THE

GARDENS' BULLETIN

STRAITS SETTLEMENTS

Vol. VIII 10th October, 1934 Part 1

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CORRIGENDUM

Ferns of Mount Kinabalu, Gardens' Bulletin, S. S. Vol. VII part 3, June, 1934.

pp. 251, 288—For X 3 in legends to text-figures of *Dryopteris urophylla* and *Pteris Holttumii,* read X 6.

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Vol. VIII 10th October, 1934 Part 1

NOTES ON MALAYAN DIPTEROCARPACEAE—II.

C. F. Symington, B.Sc.

This paper continues the series commenced by my "Notes on Malayan Dipterocarpaceæ—I" published by courtesy of the Director of Gardens, Straits Settlements in this Bulletin, Vol. VII, pt. 2 (1933). As previously, the species dealt with have been selected in no systematic sequence but are those concerned in various problems that have demanded attention from time to time.

I have first discussed the genus *Scaphula* Parker. The study of this group involved some more or less intensive work upon all our species of *Anisoptera*, the results of which are thought to be worthy of publication.

Next I have endeavoured to clarify the position with regard to the much confused species *Hopea sangal*, following my notes on which a description of its close ally *H. semicuneata* seems appropriate.

Finally I have had the pleasure of examining the dipterocarps collected in Sarawak by Mr. Richards of the Oxford University Exploration Club. Two of these collections [*Balanocarpus longiflorus* (Brandis) Foxw. and *Hopea laxa* Sym.] are of peculiar interest as they raise the whole question of the status of the anomalous genus *Balanocarpus*. Although I do not feel that my study of the plants concerned in this group is sufficiently complete for me to give an authoritative and final treatise upon it, it seems desirable that a statement of my opinions should be given in justification of the publication of these two new binomials.

As in my previous paper the concluding paragraph of my notes under each species occurring in the Malay Peninsula is addressed in particular to Malayan Forest Officers.

I wish to take this opportunity of recording my grateful appreciation of the invaluable assistance I have received from the Director of the Royal Botanic Gardens, Kew, Dr. Burtt Davy of the Imperial Forestry Institute, Oxford, the Forest Botanist, Dehra Dun, the Curator of the

Herbarium, Calcutta, the Forest Botanist, Maymyo, Mr. Henderson of Singapore, Dr. van Slooten of Buitenzorg, the Curator of the Museum, Kuching, and the Acting Chief, Division of Botany of the Bureau of Science, Manila. I should like also to express my appreciation of the enthusiasm and interest of my colleagues in the Malayan Forest Service who are mainly responsible for the collection of recent herbarium material. Without such willing co-operation as has been accorded me, research of this nature would be impossible.

Scaphula Parker in Fedd. Rep. 30: 325 (1932).

In uniting *Vatica scaphula* Dyer (=*Hopea scaphula* Roxb.) and *Anisoptera glabra* Kurz, Parker (l.c.) was of opinion that this interesting species could not be assigned to any of these genera and created for it the new genus *Scaphula*. As the recognition of this new genus would involve the transfer to another genus of two [*A. scaphula* (Roxb.) Pierre and *A. laevis* Ridl.] from among our six Malayan species of *Anisoptera*, which, as far as the forest officer or timber worker are concerned, form an essentially homogeneous group, it seems desirable to examine critically the evidence put forward in support of the new genus before making the transfer.

Undoubtedly *Scaphula* is most closely allied to *Anisoptera* Korth. and the problem resolves itself into deciding whether *A. scaphula* and *A. laevis* should be removed to the new genus *Scaphula* or the generic conception of *Anisoptera* be amended to include them. Parker, fully aware of the close affinity of *Scaphula* and *Anisoptera*, has enumerated the differences between them as follows:—

	Scaphula	Anisoptera
1. Calyx lobes in bud	open	imbricate
2. Stamens	15–20, normally 15 those opposite the sepals paired and those opposite the petals solitary. Some or all the stamens opposite the petals may be paired with the additional stamens fully developed or more or less reduced*	20–50
3. Connectives	shortly mucronate	long awned
4. Style	slender with small 3–lobed stigma passing gradually into a stylopodium as in *Dipterocarpus*	stylopodium stout and fleshy tipped with 3 short styles without well-differentiated stigmas.

* The presence of 20 stamens is evidently abnormal although not surprising. I have never met with more than 15 stamens in the flowers I have examined.

One and 3 are not of great importance as generic characters. In the flowers of *A. scaphula* I find that the calyx lobes are actually slightly imbricate in bud. The length of the connectival appendage is a very variable character within other genera of the *Dipterocarpaceae* although it is normally a reliable specific character. Occasional abnormal stamens with an awn-like appendage are to be found in *A. scaphula*. The number of stamens also is subject to great variation within some genera of this family including the genus *Anisoptera* (*Scaphula* excl.). In *A. costata, A. marginata,* and *A. Curtisii* the number of stamens varies between 23 and 30 whereas in the flowers of *A. megistocarpa* examined by me there have been from 47–54 stamens.

The main diagnostic character of *Scaphula* is the nature of the stylopodium. Reference to the figures (Pls. I—IV) will show how *Anisoptera* and *Scaphula* differ in this respect. In *Anisoptera* the ovary is surmounted by an erect, fleshy, sulcate stylopodium which is crowned with 3 (occasionally 4) short styles without well-differentiated stigmas. In *Scaphula* the ovary is surmounted by an enlarged flattened rugose disc. From this disc a slender columnar style rises rather abruptly and is terminated by three sessile stigmatic lobes. *Scaphula* differs from most species of *Anisoptera* also in being almost glabrous and in having subglobular flower buds.

Against these differences must be considered the many characters that *Anisoptera* and *Scaphula* have in common and which are not shared by other genera in the family. The *facies* of *A. scaphula* and *A. laevis* is that of an *Anisoptera*. In form and bark characters and in the structure of the secondary xylem of the wood they agree with *Anisoptera*. The structure of the embryo and the germination of the seed is as in *Anisoptera* (*vide* Foxworthy, Mal. For. Rec. 10 p. 31) and they share the peculiar character of having young parts and the undersides of the leaves furnished with minute peltate scales (fugacious in *A. scaphula*). The fruits of *Anisoptera* and *Scaphula* are essentially the same and can be distinguished only by the persistent style and stylopodium or occasionally by persistent stamens.

Whether or not *Scaphula* is worthy of generic rank must always be to some extent problematical but the writer is strongly opposed to the disruption of so characteristic and homogeneous a group as that formed by the described species of *Anisoptera*. He is of opinion that when the genus is next monographed slight alteration should be made in

the generic definition of *Anisoptera* to include *A. scaphula* and *A. laevis*. Foxworthy (l. c. p. 93) has slightly altered the generic description of van Slooten [Bull. Jard. Bot. Buitenz. III, 8: 3 (1926)] to embrace these species, but has not allowed for their distinctive form of style and stylopodium nor for the fact that they are practically glabrous. The distinctive characters of *A. scaphula* and *A. laevis* should, however, be recognised by placing them in a section [Sect. *Glabrae* Heim, Recherches sur les Dipterocarpées, p. 33 (1892)] apart from the other known species of the genus *Anisoptera*.

Anisoptera scaphula (Roxb.) Pierre, Fl. For. Cochinch. sub t. 235 (1890) in obs.: *Hopea scaphula* Roxb. Fl. Ind. 2: 611 (1832); Kurz, Prelim. Rep. For. Pegu, app. A: 19 et app. B: 29 (1875), et Fl. Brit. Burma 1: 121 & 547 (1877) : *Anisoptera glabra* Kurz in Journ. Asiat. Soc. Bengal 42, pt. 2: 61 (1873), Prelim. Rep. For. Pegu, app. A: 16 et app. B: 29 (1875), et Fl. Brit. Burma 1: 112 (1877); Dyer in Hook. f., Fl. Brit. Ind. 1: 301 (1875); Brandis in Journ. Linn. Soc. 31: 41 (1895), et Ind. Trees 67, t. 29 (1911); Guérin ex Lecomte, Fl. Gen. l'indo-chine 1: 368 (1910); non Pierre, l.c. sub t. 235 et 253; non Ridl. in Agri. Bull. S. S. & F. M. S. 1, pt. 2: 60 (1901), et in Journ. R. As. Soc. Str. Br. 54: 25 (1910) : *Vatica scaphula* Dyer in l.c.,; King in Journ. As. Soc. Bengal 42, pt. 2: 127 (1893) in obs.; Brandis in Journ. Linn. Soc. 31: 132 (1895), et Ind. Trees 72 (1911) : *Anisoptera thurifera* Ridl., Fl. Mal. Penins. 1: 219 (1922); Foxw. in Journ. Mal. Br. R. As. Soc. 5: 341 (1927) partim, Mal. For. Rec. 3: 78 (1927) partim (plate of leaves and fruit), et Mal. For. Rec. 10: 100 (1932), non Blume: *Scaphula glabra* Parker in Fedd. Rep. 30: 326 (1932); Cretzoiu in Acta Faun. Flor. Univers. Bot. 1, 9: 3 (1933) fig. 1 & 2. **Plate I.**

The various descriptions published for this species under the names *Vatica scaphula* and *Anisoptera glabra* being hardly satisfactory, I have prepared the following with the help of our Peninsula collections and Burmese material kindly lent by Calcutta and Maymyo.

Branchlets usually pale yellow-brown, glabrous, sometimes covered with light brown scales. *Leaves* oblong, elliptic—oblong or obovate, gradually or abruptly acuminate, usually slightly cordate at base but may be rounded, truncate, or even sub-cuneate, usually about 12 cm. × 6 cm. but varying between very wide limits, glabrous, coriaceous,

usually drying a light green-brown on both surfaces, the lower sometimes sparsely clothed with light-coloured scales; midrib depressed above, elevate and yellow beneath; secondary nerves 15–24 pairs, usually at an angle of over 60° to the midrib, curved and anastomosing towards the margins, with frequent distinct intermediary nerves, prominent and usually yellow on both surfaces; fine reticulations evident on both surfaces, more prominent beneath; petioles 2–4 cm., enlarged rugose and sulcate in upper half, frequently clothed with pale brown scales; stipules linear-lanceolate acuminate, 5 mm. long (may exceed 2 cm. in seedlings), densely clothed with brown scales, caducous. *Panicles* axillary and terminal, pendulous, racemose, up to 20 cm. long, puberulous or densely tomentose towards the ends; ultimate branchlets distant, 1–5 cm. long, each bearing 2–7 distichous flowers about 5 mm. apart. *Flowers* globular in bud, slightly pointed at apex, 6 mm. long including the pedicel, foetid or sickly smelling; pedicel 1.5 mm., grey or tawny tomentose; calyx cup shallow. *Sepals* slightly imbricate in bud, tomentose on both surfaces, 2 large oblong obtuse, 3 smaller ovate acuminate. *Petals* slightly twisted in bud, reflexed when expanded, ovate-oblong, glabrous or sometimes sparsely puberulous along the margins, white, falling singly. *Stamens* 15 (15–20, Parker), pairs opposite the sepals, solitary opposite the petals; filaments flattened, shorter than the anthers; anthers somewhat hastate, posterior cells smaller than the anterior; appendage to connective mucronate or rarely extended into a short awn. *Ovary* deeply embedded in the receptacle and surmounted by a rugose, tomentose, disc-like or sub-conical stylopodium; style columnar, glabrous; stigma hardly enlarged, 3-lobed. *Fruit:* stalk 2–3 mm. long, rugose, puberulous; calyx tube enclosing and adnate to the nut, globose when mature, about 1.25 cm. diam., more or less verrucose, glabrous; large calyx lobes usually linear spathulate, 14 cm. × 2.5 cm. but very variable, somewhat verrucose; 3 small lobes, linear, acuminate or rounded at apex, up to 2.5 cm. long, also very variable; nut crowned with the enlarged tomentose disc-like stylopodium and erect style (a few stamens occasionally persist for a long time but have fallen before the fruit is mature). *Embryo:* cotyledons unequal; dorsal cot. occupying the entire upper portion of the ovary, large; placental cot. lying below the dorsal, smaller; radicle medial and horizontal.

Parker, in his notes on the genus *Scaphula*, has given an account of the early history of this interesting species which has been known in Burma variously as *Vatica scaphula* and *Anisoptera glabra*. As Parker points out,

although Kurz realised that these two species belonged to the same genus he did not realise that they are actually conspecific. Thus, although Kurz in 1877 proposed and Pierre in 1890 used the combination *Anisoptera scaphula*, it was not until 1932 that *A. glabra* Kurz was reduced to synonymy with *V. scaphula* Dyer by Parker. The last author, however, being (as were both King and Brandis) fully aware of the anomalous nature of the species, was not of opinion that it could remain in either of the genera to which it had previously been assigned. He recognised its close affinity to *Anisoptera* but considered that the floral characters were such as to warrant the creation of a new genus *Scaphula*. My reasons for retaining this species in the genus *Anisoptera* are given fully in my notes upon the genus *Scaphula* (p. 2).

In 1901 and again in 1910 Ridley recorded *Anisoptera glabra* from the Malay Peninsula but the collections examined by him were actually *A. laevis* Ridl., a mistake which he corrected in 1922 when publishing the description of his new species in the Flora of the Malay Peninsula. These collections, originally referred by Ridley to *A. glabra*, were examined by Foxworthy who, in 1911 (Phil. Journ. Sc. Bot. 6: 257), identified them with *A. thurifera*.

Our earliest authentic collection of *A. scaphula* from the Peninsula is C. F. 453 (Kew No. 32) which was collected in Plus Forest Reserve in 1912 and is the specimen referred by Ridley to *A. thurifera* in his flora. This collection has fruit hardly mature and is in a condition in which it is difficult to distinguish these two species.

Thus Foxworthy's *A. thurifera* from the Malay Peninsula was actually *A. laevis* while Ridley's *A. thurifera* was *A. scaphula*.

In 1927 (Journ. Mal. Br. R. As. Soc. 5: 341 and Mal. For. Rec. 3: 78) Foxworthy included under *A. thurifera* collections of both *A. laevis* and *A. scaphula*. This is evident from the fact that he says that "*A. thurifera* Bl. is the commonest species", but gives a plate of leaves and fruit based on C. F. 11685 which is *A. scaphula*. His former conception of the species is explained by Foxworthy in Mal. For. Rec. 10 (1932) but here, as in his previous two publications, he continues to record *A. glabra* Kurz as a synonym of *A. thurifera* (Blco.) Bl. This is quite unjustified although sterile specimens of these species are undoubtedly rather alike.

We may now say definitely that *A. thurifera* Bl. has never been collected in the Peninsula.

Collections examined—

BURMA: Kurz 116 & 2117 (Auth. spec. of *A. glabra* Kurz); King's coll. 144 & 164; Brandis 114; Calcutta Nos. 885, 952, 966, 8089, 8358 & 8397; Maymyo Nos. 6505 (Field No. 2545), 7564 (Field No. 5062) & 14146 (Field No. 11892); For Dept. Tenas. Circ. 351; Dehra Dun Nos. 1188, 5023 & 39751.

MALAY PENINSULA: KEDAH: C. F. 21735.
PERAK: C. F. 453 (Kew No. 32), 10378, 30772 & 30807.
KELANTAN: C. F. 32722.
TRENGGANU: C. F. 10242.
PAHANG: C. F. 2399.
SELANGOR: C. F. 9993, 11685, 14357, 22008, 22010 & 24962.
NEGRI SEMBILAN: C. F. 631.

Anisoptera scaphula is a large smooth-leaved form of *mersawa* not uncommon towards the north of the Malay Peninsula. It is identical with the tree known in Burma by the vernacular names of *boilshara, taungsagaing, kaung humu,* etc. and producing the timber known as "mascal wood". The former identification of this tree with *Anisoptera thurifera* of the Philippines is shewn to be wrong.

Anisoptera lævis Ridl., Fl. Mal. Penins. 1: 219 (1922); Brandis in Journ. Linn. Soc. 31: 41 (1895) (in obs. sub A. glabra); Foxw., Mal. For. Rec. 10: 101 (1932); *Anisoptera glabra* Ridl. in Agri. Bull. S. S. & F. M. S. 1, pt. 2: 60 (1901) et in Journ. R. As. Soc. Str. Br. 54: 25 (1910); non Kurz: *Anisoptera thurifera* Foxw. in Phil. Journ. Sc. Bot. 6: 257 (1911) partim, quoad spec. malay., in Journ. Mal. Br. R. As. Soc. 5: 34 (1927) partim et Mal. For. Rec. 3: 78 (1927) partim (plate of bole and bark); non Blume, non Ridl., Fl. Mal. Penins. l.c. **Plate II.**

The following description is prepared as an aid to comparison of this species with its very close ally *A. scaphula* together with which it forms a group distinct from all other known species of the genus.

Branchlets slightly sulcate towards the ends when dry, glabrous or more or less densely clothed with reddish scales. *Leaves* oblong to elliptic—oblong or lanceolate, gradually or abruptly acuminate, rounded or subcuneate at base, 8–10 cm. × 2.5–4.5 cm., coriaceous, when dry green-brown above, reddish beneath owing to the more or less dense covering of scales; midrib depressed above, elevate and reddish beneath; secondary nerves 10–15 pairs at an angle of about

50° to the midrib, curved and anastomosing towards the margins with occasional distinct intermediary nerves, prominent on both surfaces, elevate beneath; fine reticulations conspicuous particularly upon the lower surface; petioles 1.5–2.5 cm., enlarged and rugose in the upper half, usually clothed with minute reddish scales; stipules lanceolate, densely squamate, caducous. *Panicles* axillary and terminal, pendulous, racemose, up to 18 cm. long, densely stellate fulvous tomentose towards the ends of the branchlets; ultimate branchlets distant, up to 2 cm. long, each bearing 2–8 closely set distichous flowers. *Flowers* globular in bud, pointed at the apex, 5 mm. long including the pedicel; pedicel rugose, 1.5 mm., fulvous tomentose; calyx cup shallow. *Sepals* valvate, 2 oblong obtuse, slightly larger than the remaining 3 which are deltoid acute, all fulvous tomentose on both surfaces. *Petals* slightly twisted in bud, reflexed when expanded, oblong, obtuse, glabrous on both surfaces or sparsely ciliate outside on the portion exposed in bud, pale yellow (Foxworthy). Stamens 15 (15–20, Foxworthy) in pairs opposite the sepals, solitary opposite the petals; filaments flattened, less than half the length of the anthers; anthers oblong, broader at the base, posterior cells smaller than the anterior; appendage to connective mucronate. *Ovary* deeply embedded in the receptacle, surmounted by the rugose tomentose disc-like stylopodium; style columnar, sulcate, glabrous; stigma slightly enlarged, obscurely 3-lobed (*see* Pl. II). *Fruit:* stalk 2–3 mm. long, verrucose, sub-glabrous; calyx tube enclosing and adnate to the nut, globose when mature, 1–1.5 cm. diam., minutely verrucose, glabrous; 2 large calyx lobes linear spathulate, usually about 10 cm. × 1.5 cm., but may be up to 14 cm. long; 3 small lobes linear acuminate, 1–2.5 cm. long; nut crowned by the enlarged tomentose disc-like stylopodium and persistent style. *Embryo* as in *A. scaphula*.

The earliest collection of this species is probably Alvins (Cantley's collector) 2160 from Merlimau in Malacca made in 1885, which is most likely the specimen Ridley had in mind when he recorded *Anisoptera glabra* as "*mersawa merah*" in 1901.

Other early collections are Hólmberg 841 (1891) and Derry 1166 (1892), also from Malacca, and Ridley 6886 (Kew No. 210) collected in the Botanic Gardens Singapore in 1895. The first was examined by Brandis who, in 1895, made some pertinent notes on the specimen and suggested that it might be a new species.

In 1910 Ridley cited the four collections mentioned above, all of which were in fruit, under *A. glabra*, but in his Flora in 1922 he evidently realised that they represented

a distinct species, as Brandis had suggested, and described them under the name of *A. laevis* Ridl.

Foxworthy's early conception of this species is explained in my notes under *A. scaphula*. In Mal. For. Rec. 10 his conception is quite clear but C. F. 631, cited under *A. laevis*, is actually *A. scaphula*. Foxworthy (p. 102) remarks that it is difficult to distinguish this species from *A. thurifera* without flowering material. Personally I do not find it so. In fruit *A. laevis* is distinct by reason of its peculiar style and stylopodium while sterile specimens have smaller leaves with fewer nerves and are furnished with distinctive reddish scales on the under surface. I do, however, find sterile specimens of *A. scaphula* and *A. thurifera* almost indistinguishable in certain conditions.

Collections examined—

MALAY PENINSULA: PERAK: C. F. 0103, 7050, 10394, 11020, 25536, 25602, 25823, 28560, 29915, 30660, 32262 & 33789.

KELANTAN: C. F. 30720.

PAHANG: C. F. 4635, 4996, 5058, 5487, 5504, 10587, 15621, 26104, 28214 (?) & 28247.

SELANGOR: C. F. 9645, 10939, 24025, 24033, 24064, 24455, 24704 & 27942.

NEGRI SEMBILAN: C. F. 0638, 0647 & 23755.

MALACCA: Holmberg 841; S'pore 2160 (Alvins); Derry 1166; C. F. 18276.

SINGAPORE: S'pore 6886 (Kew No. 210) Ridley (auth. spec. of *A. laevis* Ridl.) & 2047.

Anisoptera laevis is our most common form of smooth-leaved *mersawa*. Notes are made on early collections of the species and a botanical description is given for comparison with the closely related *A. scaphula*, a less common *mersawa* found mainly in the north of the Peninsula.

Anisoptera costata Korth., Verh. Nat. Gesch. Ned. Overz., Bot. 67, tab. 6, fig. 1–9 (1839–'42); Ridl. in Agri. Bull. S. S. & F. M. S. 1: 60 (1901); in Journ. R. As. Soc. St. Br. 54: 25 (1910) partim, et Fl. Mal. Penins. 1: 218 (1922) partim; V. Sl. in Bull. Jard. Bot. Buitenz III, 8:7, fig. 1 (1926); Foxw. Mal. For. Rec. 3: 79 (1927) in obs., et Mal. For. Rec. 10: 97 (1932). **Plate III A.**

This species, described from Borneo by Korthals in 1839, was first collected in the Peninsula by Holmberg in Malacca in 1891. Ridley recorded this collection as *A. costata* in 1900 but in 1910 he included along with it his 6684 from the Gardens' Jungle, Singapore. This latter

collection is one of those upon which van Slooten founded his *A. megistocarpa.*

This confusion of two species under the name of *A. costata* persisted in the Flora of the Malay Peninsula where the specimens cited from Batu Tiga (Holmberg) and Bangi (Mitchell, C. F. 1042) belong to *A. costata* and the remainder to *A. megistocarpa.* Van Slooten cleared up the confusion in 1926 when he described his *A. megistocarpa* but under *A. costata* cited only one collection (C. F. 1042) from the Malay Peninsula. Foxworthy (Mal. For. Rec. 10) also cites only the one collection, having also confused this species with *A. megistocarpa.* He records *A. megistocarpa* from Kuala Lumpur and Upper Perak on the evidence of collections (C. F. 13712 and 10409) which are actually *A. costata.*

It will be seen from the citation of specimens that *A. costata* is by no means as rare a tree in the Peninsula as has been supposed.

Under *A. oblonga* I have made some notes concerning the relationship of *A. costata* to *A. oblonga* and other closely allied species.

Collections examined—

SIAM: C. F. 2993.

MALAY PENINSULA: PERAK: C. F. 10409, 30310 & 30903.

SELANGOR: C. F. 1042, 9992, 13712, 14840, 17073 & 32667.

MALACCA: Holmberg 768.

SUMATRA: F. R. I., E. No. 399 & 546, T. No. 330 & 896.

JAVA: F. R. I., E. No. 1367.

BORNEO: Korthals, G. Sakœmbang (Auth. spec. of *A. costata* Korth.).

Anisoptera costata is a form of *mersawa* with rather larger leaves, yellow and hairy on the undersurface. It is found on low-lying land and is here shown to be more common than has been supposed. Reference is made to the former confusion of this species with *A. megistocarpa.*

Anisoptera oblonga Dyer in Hook. f. Fl. Brit. Ind. 1: 301 (1874); Pierre, Fl. For. Cochinch. 15, t. 235 et 236 (1890) in obs.; Brandis in Journ. Linn. Soc. 31: 42 (1895); Guérin ex Lecomte, Fl. Gen. l'indo-chine 1: 369 (1912): *Shorea nervosa* Kurz, For. Fl. Brit. Burma 1: 119 (1877); Pierre, l.c. t. 235 in obs.; Brandis l.c.: ? *Anisoptera cochinchinensis* Lanessan, Pl. Utiles Col. Fr. 268 (1886); Pierre, l.c. t. 235 A et t. 253; Brandis, l.c.; Heim in Bot. Tidsskr. 25, 1: 44 (1902); Guérin, l.c. 367; Craib, Fl. Siam. Enum. 1: 139 (1925);

Lecomte, Bois d'indo-chine 115, fig. 15, *3*, *4* & *5* (1926): ? *Anisoptera glabra* Pierre, l.c. t. 235 B, et Guérin, l.c. 368, non Kurz: ? *Anisoptera robusta* Pierre, l.c. t. 236; Brandis, l.c.; Guérin, l.c. 368; Craib, l.c. 140: ? *Anisoptera marginatoides* Heim in l.c.; Guérin, l.c. 369; Craib, l.c. 139. **Plate III B.**

Anisoptera oblonga was first collected by Griffith in Mergui and described by Dyer in 1872. In 1877 Kurz described his *Shorea nervosa* from a sterile collection from Tenasserim (not seen by me) which Pierre and Brandis later identified as *A. oblonga* Dyer.

Up to the time of Foxworthy's "Dipterocarpaceæ of the Malay Peninsula" (Mal. For. Rec. 10 (1932)) no collection suggestive of this species had been made in the Peninsula, but in 1933–34 three flowering collections were made in Kedah and Kelantan which exactly match Burmese collections of *A. oblonga*.

Of the collections examined by me I consider the following to be *A. oblonga* Dyer without doubt—

BURMA: Griffith 939 (Auth. spec. of *A. oblonga* Dyer); Maymyo 7513 (Field No. 5047), 9378 (Field No. 8055) & 9403 (Field No. 8058).

MALAY PENINSULA: KEDAH: C. F. 21663 & 30133. KELANTAN: C. F. 29096 & 33284.

After studying carefully the above collections and collections of *A. costata*, and after making numerous floral dissections, I am struck with the very close affinity of these species. Indeed I can find no satisfactory character upon which they can be separated, other than the nature of the epidermal covering. All the collections of these species that I have examined have been furnished, on the undersides of the leaves and to some extent on the branchlets and panicles, with three forms of trichome—1, peltate scales; 2, dense tufted stellate hairs; and 3, long simple hairs or stellate hairs with a few long arms (all gradations are found between 2 and 3). In *A. costata* usually all three forms of trichome are plentiful but in *A. oblonga* "3" are almost absent and "2" are sparsely distributed.

This difference between *A. oblonga* and *A. costata* may be a local variation of a single species due to climate condition rather than a specific difference. However, it would not be wise to unite these species until more collections are available for study.

I also consider that *A. cochinchinensis* Lanessan and *A. robusta* Pierre probably do not differ specifically from *A. oblonga*. Nor am I satisfied that *A. glabra* Pierre is distinct. From the evidence of Pierre's description and

figure it is clear that his *A. glabra* is not *A. glabra* Kurz [=*A. scaphula* (Roxb.) Pierre].

Pierre enumerates the diagnostic characters of *A. cochinchinensis* thus—"*Spécifiquement, nous distinguons l'* A. cochinchinensis *de l'* A. oblonga *Dyer, par les feuilles munies d'un plus grand nombre de petites côtes; par des fleurs un peu plus grandes, contenant de 30 à 35 étamines au lieu de 25; par les nervures des ailes du câlice fructifère, également élevées sur les deux faces. Ses feuilles sont un peu plus oblongues que celles de l'* A. costata, *et moins souvent cordées, plus glabres; ses anthères sont glabres, ainsi que les ailes de son calice fructifère, d'ailleurs moins larges et moins longues*".

All the characters mentioned by Pierre are subject to considerable variation within the species in *Anisoptera*. Even the number of stamens I have found to vary within wide limits in some of the species and I have counted 30 stamens in the flowers of one Burmese collection of typical *A. oblonga*.

Pierre evidently felt that the evidence for specific separation of his *A. cochinchinensis* and *A. glabra* was slender because he adds—"*On ne saurait dissimuler le grand rapprochement de ces trois espèces (A. cochinchinensis, A. oblonga* and *A. costata), et même de celle—ci et de la suivante* (*A. glabra* Pierre), *qui se fait remarquer surtout par son calice fructifère, dont les petites ailes sont plus étroites et plus longues.*"

Concerning *A. robusta,* Pierre says—"*C'est avec beaucoup d'hésitation que je distingue cette espèce des* A. glabra, A. oblonga *et* A. costata, *trois espèces ayant une étroite affinité. De la première surtout, il est très difficile de la séparer si l'on considère que le fruit est seul connu et qu'il est possible qu'elle soit l'* A. oblonga. *De toutes deux, elle diffère par ses feuilles velues et par l'extrémité arrondie de ses feuilles. De l'* A. oblonga, *elle se distingue encore par des fleurs plus grosses, des sépales plus longs et plus aigus. Dans la plante de Mergui, type de l'* A. oblonga, *les plus grands sépales n'ont que deux mm. de longueur et sont pubérulents. Les pétales y ont 4 mm. ½ de longueur et les nervures sont au nombre de 7. On y trouve 25 étamines. Les anthères glabres longues d'un mm. y sont terminées par un connectif long de 2 mm. ½. Le style y est ovoide pubérulent. J'avais pensé aussi, avant d'avoir vu la plante de Korthals, que c'etait l'* A. costata, *mais là les feuilles sont cordées acuminées, le nombre des petites côtes est de 20–24, les anthères sont pubescentes et le style linéaire—oblong.*

De l' A. cochinchinensis *on ne peut distinguer l'* A. robusta *que par les boutons plus allongés, par son inflorescence, ses feuilles velues et le nombre de ses étamines."*

The only authentic specimen of *A. robusta* I have examined is Thorel 2696 which has flowers practically identical with those I have dissected on some of the sheets of *A. costata.* The predominance of the third form of trichome appears to be the only character that distinguishes *A. robusta* Pierre from *A. costata* Korth., *A. oblonga* Dyer, *A. cochinchinensis* Lanessan, and *A. glabra* Pierre (non Kurz) all of which may be proved to be conspecific when more complete material is available.

I have reason to suspect that *A. marginatoides* Heim which is represented by a single fruiting specimen from Chantaburi (not seen by me) may also have to be reduced to synonymy with the above. There is nothing in the description of the species to preclude such reduction.

Under *A. costata* Korth. I have cited the collections examined that I consider typical of Korthal's species and under *A. oblonga* Dyer those that I consider typical of Dyer's form. The following collections probably do not differ specifically from the above but as they are hardly typical of either it seems desirable to keèp them separate meanwhile—

CAMBODIA: Foxworthy Nos. 4, 5 & 12.

COCHIN CHINA: Pierre 1550 (auth. spec. of *A. cochinchinensis* Pierre), Thorel 2696 (*A. robusta* Pierre).

BURMA: Calcutta 964 & 8062; Bot. Survey Tenas. Circ. 328 (Maymyo 605 N/972).

SIAM: For. Dept. Siam No. 871; S'pore 2708.

MALAY PENINSULA: KELANTAN: C. F. 29122, 29082, 29969, 32725 & 33408.

PAHANG: 5151, 28323 & 29969.

Anisoptera oblonga is a form of *mersawa* occurring in Burma. It has recently been collected in Kedah and Kelantan. It is suggested that this tree may not differ specifically from *A. costata* and certain other forms described from Cochin China and Siam, but more collections are required to decide the point.

Anisoptera marginata Korth. Verh. Nat. Gesch. Ned. Overz. Bez., Bot. 66, t. 6, fig. la-13a (1839-'42); Ridl., Fl. Mal. Penins. 1: 219 (1922); V. Sl. in Bull. Jard. Bot. Buitenz. III, 8: 5 (1926); Foxw., Mal. For. Rec. 10: 96 (1932): ? *Anisoptera grandiflora* Brandis in Journ. Linn. Soc. 31: 43, pl. 2, fig. 29 (1895); V. Sl., l.c. 10, in nota. **Plate III C.**

Van Slooten has given an excellent description of this species which is reproduced by Foxworthy in Mal. For. Rec. 10. In the flowers examined by me I find that the number of stamens varies from 25-28 and that occasionally there are 4 styles. Four styles have also been noticed in *A. oblonga*. Occasionally on dissection there appear to be more than 4 styles. This is due to the fact that each style is readily divisible into two, a condition found in all the species of *Anisoptera* I have examined (sect. *Glabrae* excepted).

A. marginata was originally described by Korthals from Borneo and was first recorded from the Malay Peninsula by Ridley in 1922 on the evidence of a single collection (C. F. 3601) from Kuantan. In 1926 van Slooten cited only this collection and in 1932 Foxworthy added only one other from Ulu Rompin. It is now possible to add considerably to the citation of collections from the Malay Peninsula. It appears that this species is not uncommon in our swamp or semi-swamp forests near the coast.

Van Slooten has suggested that *A. grandiflora* Brandis may prove to be a synonym of *A. costata* Korth. I am of opinion that it is only a large-leaved collection of *A. marginata*. This is, however, difficult to prove because these two species are essentially similar in flower structure, the best diagnostic character being the more numerous veined and more pubescent leaves of *A. costata*.

Collections examined––

MALAY PENINSULA: PERAK: C. F. 27804, 27806 & 30753.

SELANGOR: C. F. 23927, 23948, 24562, 27070, 29717, 29718, 29730, 29738, 30771 & 36029.

PAHANG: C. F. 3601 & 15496.

SINGAPORE: C. F. 30759.

SUMATRA: F. R. I. Nos. 382, 385, 398 & 403; F. R. I. No. b.b. 5788.

BANGKA: Teysmann sine no.

JAVA: Cult. in Hort. Bog, IX-D-171.

BORNEO: ? Haviland (Garai) 959 [auth. spec. of *A. grandiflora* Brandis]; Garai sine no. 26.2.92 (fruit—possibly from same tree as 959); F. R. I. No. b.b. 14895 & E. No. 5056.

Anisoptera marginata is a form of *mersawa* found usually in semi-swamp jungle such as Utan Melintang or Telok. It was recently discovered in Sungei Buloh Reserve.

Anisoptera megistocarpa V. Sl. in Bull. Jard. Bot. Buitenz. III, 8: 12, fig. 2 (1926); Foxw., Mal. For. Rec. 10: 98 (1932): *Anisoptera costata* Ridl. in Journ. R. As.

Soc. Str. Br. 54: 25 (1910) partim, et Fl. Mal. Penins. 1: 218 (1922) partim; Burkill, Journ. Str. Br. R. As. Soc. 75: 43 (1917); non Korth. **Plate IV A.**

Van Slooten and Foxworthy have given very complete descriptions of this species and van Slooten has published a very good figure of the branchlet, inflorescence and fruit. I should like to add the following notes—In examining the flowers of Ridl. 6684, Burkill 526, and C. F. 624 I find the number of stamens to vary between 47 and 54 (30-32 in published descriptions) and that the arrangement of the styles is essentially as in *A. costata* etc., *i.e.*, there are three closely appressed styles with minute stigmas. On dissection each style is found to be notched at the apex and easily divisible into two (*vide* my notes under *A. marginata*).

This species was collected by Ridley in the Botanic Gardens Jungle, Singapore as early as 1894. In 1910 and again in 1922 Ridley recorded these collections along with authentic material of *A. costata* under the latter name. It was not until van Slooten described his *A. megistocarpa* in 1926 that the Peninsula collections of these two species were separated, but recently confusion has again occurred (*vide* my notes on *A. costata*).

We have at Kepong three sterile collections (C. F. 28702, 30561 and 30610) from Brunei which look like small-leaved specimens of *A. megistocarpa*. It is probable, however, that they represent an undescribed species (*vide* also my notes on *A. Curtisii*).

Collections examined—

MALAY PENINSULA: PERAK: C. F. 27337, 27821 & 31083.
PAHANG: C. F. 29951.
NEGRI SEMBILAN: C. F. 427, 624 & 669.
MALACCA: C. F. 2091 & 9296.
SINGAPORE: Ridley 6684 (cited as 6634 by V. Sl.) (fl. and ft.—auth. spec. of *A. megistocarpa* V. Sl.); S'pore Gdns. No. 526; S'pore sine no. (Burkill 1916) & sine no. (Md. Nur 1924).

Anisoptera megistocarpa is a form of *mersawa* with a conspicuous dark crown due to the hairy red-brown under-surfaces of its leaves. It may be seen in Bikam, Pasir Panjang (N. S.), and the Malacca among other reserves, but is not plentiful.

Anisoptera Curtisii Dyer ex King in Journ. As. Soc. Bengal 62, pt. 2: 100 (1893); Brandis et Gilg in Engler, Nat. Pflanzenfam. III, 6: 263, t. 122, fig. F. (1894) and 2nd edit. 21: 259, t. 112 fig. F. (1925); Brandis in Journ. Linn. Soc. 31: 42 (1895); Burkill, Journ. Str.

Br. R. As. Soc. 81: 51 & 63 (1920); Merr., Bibl. Enum. Born. Pl. 400 (1921); Ridl. Fl. Mal. Penins. 1: 213 (1922); V. Sl. in Bull. Jard. Bot. Buitenz. III, 8: 11 (1926); Foxw., Mal. For. Rec. 3: 79 (1927) in nota, et Mal. For. Rec. 10: 99 (1932); non Foxw. in Philip. Journ. Sc. Bot. 6: 255, t. 41 (1911), l.c. 13: 181 (1918), et ex Merr., Enum. Phil. Fl. Pl. 3: 92 (1923): *Anisoptera Curtisii* var. *latifolia* King, l.c. **Plate IV B.**

The only description of this species based on both flowering and fruiting material is that of Foxworthy in Mal. For. Rec. 10. The following is an amplified description based upon my own experience of our collections.

Branchlets rugulose, slightly flattened, densely clothed with a scabrous, ferruginous, fugacious, stellate tomentum. *Leaves* oblong or elliptic-oblong to obovate, usually rather abruptly tapering at both ends, apex acute or shortly acuminate, base rounded, obtuse to slightly cordate (rarely acute), usually about 10 cm. × 4 cm. but may be much smaller or up to 14 cm. × 7 cm. (var. *latifolia* King), glabrous, shining red-brown above when dry, beneath, when young, usually sparsely pubescent and pale yellow, later glabrescent and densely ochraceous lepidote; midrib deeply depressed above, somewhat purple beneath; secondary nerves 18–20 prs. conspicuously looped towards the margins, with occasional short intermediary veins, sometimes slightly depressed above, conspicuously raised and purplish beneath; reticulations visible on both surfaces; petioles enlarged in the upper portion, 1–2.5 cm., rugulose, scabrous, squamate; stipules linear oblong, sub-falcate, acute, 7 × 2 mm., scabrous, caducous. *Panicles* lax, pendulous, racemose, up to 15 cm. long, rugose, scabrid; ultimate branchlets distant, up to 4 cm. long, each bearing 3–10 distichous flowers 2.5–5.0 mm. apart. *Flowers* acuminate in bud, 11.0 mm. including the pedicel; pedicel 3 mm., scabrid tomentose. *Sepals* slightly imbricate in bud, sub-equal in length, 2 ovate oblong obtuse, 3 ovate acuminate, all stellate tomentose outside, pubescent inside. *Petals* in bud slightly contorted, involute and reflexed at apex, lanceolate acuminate, glabrous except along one margin outside, "greenish white" (Haniff, S'pore 3692). *Stamens* 24–26 (usually 25) in two whorls; filaments longer than the anthers, slightly flattened, broader towards the base; anthers oblong, posterior cells much smaller than the anterior; appendage to connective filiform, more than 3 times as long as the anther. *Ovary* 2/3 inferior, tomentose, surmounted by a sub-globose, sub-sulcate, tomentose stylopodium; styles 3 (occasionally 4),

short, glabrous, closely appressed in young flowers, each notched at apex and easily divisible into 2; stigmas minute. *Fruit:* stalk 4 mm. long, puberulous; calyx tube companulate, adnate to 2/3 of the nut, about 1.2 cm. diam. and 1 cm. high, lævigate or sub-verrucose puberulous; 2 large calyx lobes linear-spathulate, usually about 9 cm. × 1.2 cm. but may be up to 12 cm. × 2 cm., minutely puberulous or glabrate; 3 small lobes linear acuminate, up to 1.5 cm., puberulous or glabrate; nut 2/3 enclosed in the calyx cup, globular, about 1 cm. diam., glabrate or puberulous, surmounted by the conical stylopodium and remnants of the styles (stamens frequently persist for a long time but have fallen before the fruit reaches maturity).

The earliest collections of this species were made in the Larut hills by Kunstler in 1882 and in Penang by Curtis in 1885–92. Upon these collections King founded his species in 1893 using Dyer's manuscript name. One of Curtis's collections has broader leaves than the others, which fact induced King to form for it the variety *latifolia*. Subsequent authors, however, are agreed that varietal separation is not justified.

Although it would be surprising to find *A. Curtisii*, which is so widely distributed on hills in the Malay Peninsula, strictly confined to this portion of the Malayan region, a wider distribution seems hardly sufficiently proven. The collection on the evidence of which Foxworthy (Mal. For. Rec. 10) records the species from Peninsular Siam, and Burmese collections under the name of *A. Curtisii* in the herbariums of Maymyo and Calcutta, are, I consider, related to *A. oblonga* (*see* citations on p. 13).

From Sumatra van Slooten records the species on the evidence of three sterile collections which I have not seen. From Borneo Brandis recorded a collection by Burbidge, and van Slooten added several other collections from that island. Of these I have examined Haviland, sine no. (July 1905, Brunei) and bb. 8156 (ex herb. Bog.) and am of opinion that they represent an undescribed species with the *facies* of a small-leaved form of *A. megistocarpa*. Recent sterile collections from Brunei (C. F. 28702, 30561 and 30610) are from the same species.

Foxworthy has recorded *A. Curtisii* from the Philippines but I am in agreement with van Slooten who questions his identification. I have examined Bur. Sci. Phil. 8985 cited by Foxworthy under *A. Curtisii* and I am of opinion that they are more correctly referable to *A. brunnea* Foxw. a species closely related to *A. thurifera* (Blco.) Bl.

Although superficially *A. Curtisii* is, as van Slooten and Foxworthy have remarked, probably most liable to be

confused with *A. costata* and *A. marginata,* its natural affinity, I venture to suggest, is rather with *A. thurifera* Bl. *A. thurifera* has almost twice as many stamens but the stylopodium and styles, as well as the other flower parts, are very alike; this may be seen by comparison of floral dissections given on plate IV B & C.

Collections examined—

MALAY PENINSULA: PENANG: Curtis 4428 (3 coll.) & sine no. Govt. Hill, 1893, fl. & ft. (Auth. specs. of *A. Curtisii* Dyer); Curtis 1400 (auth. spec. of *A. Curtisii* var. *latifolia* King); Fox 78 & 85; Haniff, sine no. (1918); S'pore 1521, 3281, 3481, 3692, 3723, 3762 & 4566; C. F. 10845, 11662, 27781 & 28017.
PERAK: Kunstler 3618 & 3706; C. F. 16585, 24635, 25475, 25488, 25546, 25601, 28559, 28563 & 32180.
DINDINGS: C. F. 16591 & 27848.
KELANTAN: C. F. 32717 & 33409.
TRENGGANU: C. F. 26747, 26752 & 26761.
SELANGOR: C. F. 16009, 22942, 23657, 24029 & 27136.
NEGRI SEMBILAN: C. F. 742, 1192, 2103 & 18884.
SINE LOC.: C. F. 11713.

Anisoptera Curtisii is a form of *mersawa* with small bright yellow leaves found upon hills particularly in the northern portion of the Peninsula. It is very plentiful on Penang Island where it was first collected and is apparently known as *rengkong.* The plant is described and its probable distribution outside the Malay Peninsula is discussed.

Hopea sangal Korth. in Verh. Nat. Gesch. Bot. 75 (1839-'42); Blume, Mus. Bot. Lugd. Bat. 2: 34 (1852); Miq. Fl. Ind. Bat. 1, pt. 2: 504 (1859); A.DC. in DC. Prod. 16, pt. 2: 635 (1868); V. Sl. ex Heyne, Nutt. Plant. Ned. Ind. 2nd edit.: 1111 (1927): *Petalandra micrantha* Hassk., Hort. Bog. Descr. 105 (1858); Miq., l.c. 505; A. DC. in l.c.; King in Journ. Asiat. Soc. Bengal 62, pt. 2: 126 (1893), in nota sub H. micrantha Hook. f.: *Hopea fagifolia* Miq., Fl. Ind. Bat. Suppl. 490 (1860); Scheff. in Nat. Tijdschr. Ned. Ind. 31: 351 (1870); Brandis in Journ. Linn. Soc. 31: 65 (1895); Bœrl., Cat. Hort. Bog. 1 & 2: 103 (1899); Koord. & Val., Boomsoort. Java 5: 124 (1900); Sym. in Gdns. Bull. S. S., 7, pt. 2: 151 & 154 (1933) in nota: *Hopea diversifolia* Scheff., l.c., Burck in Ann. Jard. Bot. Buitenz. 6: 239 (1887), et Brandis in l.c. 64, non Miq., l.c. 491; Foxw. Mal. For. Rec. 10: 123 (1932) in obs.: *Hopea odorata* Auct. (1876–1927), partim, quoad syn. H. sangal: *Doona odorata* Burck in l.c. 233 quoad syn. H. sangal: *Doona micrantha* Burck in l.c. 234: *Doona*

javanica Burck in l.c. 235, t. 29, fig. 7: *Hopea micrantha* Benth. et. Hook. f. ex Heim, Rech. Diptéroc. 64 (1892) in obs.: *Hopea Hasskarliana* Heim, l.c.: *Hopea javanica* Heim l.c.; Brandis in l.c. 65: *Hopea Curtisii* King in l.c. 124 et in Ann. Bot. Gard. Calcutta 5: 155, pl. 187B (1896); Brandis in l.c. 65; Burkill, Journ. Str. Br. R. As. Soc. 81: 66 (1920) fig. 113–120; Ridl., Fl. Mal. Penins. 1: 236, fig. 22a (p. 212) (1922); Foxw., l.c. 130: *Hopea globosa* Brandis in l.c. 61; Ridl. in Journ. Str. Br. R. As. Soc. 54: 26 (1910) et Fl. Mal. Penins. 1: 236 (1922); Foxw., l.c. 121: *Hopea Lowii* Dyer ex Brandis in l.c. 63; Ridl. in Journ. Str. Br. R. As. Soc. 73: 143 (1916) et Fl. Mal. Penins. 1: 237 (1922); Foxw., l.c. 123: *Doona micrantha* var. *macrosepala* Bœrl., MSS. in Herb. Bog. (1900): *Hopea fagifolia* var. *fol. latioribus* Bœrl. MSS. in Herb. Bog. (1900); *Hopea fagifolia* var. *javanica* Bœrl., MSS. in Herb. Bog. (1900): *Hopea macrosepala* Bœrl., MSS. in Herb. Bog. (1900): *Hopea multiflora* Foxw., l.c. 119, partim, non Brandis: *Hopea albescens* Foxw., l.c. 122, non Ridl. **Plate V.**

The most complete description of this species is given by Foxworthy under *Hopea Curtisii* but as that was based upon a limited number of specimens it seems desirable to recast the description to cover all the collections here considered to be *H. sangal.*

Branchlets dark purple when dry, lenticellate, pale fugacious tomentose towards the ends. *Leaves* usually ovate lanceolate but very variable from lanceolate to broadly ovate, apex acuminate, base slightly unequal rounded to cuneate, usually about 10 cm. × 4.5 cm. but varying between wide limits, grey-green or tawny coloured and shining above, usually darker beneath and glabrous or sparsely stellate puberulous upon the nerves; midrib slightly depressed above, tomentose to glabrous, strongly elevate and usually puberulous beneath; secondary nerves 10–14 pairs, strongly elevate on the lower surface, commonly with barbate domatia in the axes of the lower pairs; tertiary nerves rather obscure, joining the secondaries in numerous more or less parallel lines; petioles usually puberulous and rugose, about 1 cm.; stipules linear, about 3 mm. long, falling very early. *Panicles* axillary and terminal, pendulous, racemose, when axillary shorter than the leaves, grey or tawny tomentose; ultimate branches about .5 cm. apart, up to 2.2 cm. long, each bearing 6–15 closely set secund flowers. *Flowers* oval in bud, 3 mm. long including the pedicel; pedicel about 1 mm., tomentose. *Sepals* imbricate; two ovate or oblong, thick, tomentose outside and on the upper half

inside; three smaller, more or less rotundate and irregular, tomentose outside only.* *Petals* contorted in bud, oblong, fimbriate at the apex, tomentose outside on the portion exposed in bud, white. *Stamens* 10, two appressed to each petal; anthers oblong, the posterior cells almost as large as the anterior; filaments a little longer than the anthers with broad flattened overlapping bases; appendage to connective filiform, about the same length as the anther. *Ovary* broadly cylindrical truncate, puberulous on the upper portion which may be considered to be the stylopodium, glabrous on the lower; style less than half as long as the ovary, glabrous; stigma minute. *Fruit:* stalk 1 mm. long, tomentose; calyx lobes united to form a flat open tomentose receptacle; 2 large calyx lobes spathulate, usually about 7 cm. × 1.7 cm., 8–10 nerved, puberulous towards the base; 3 small lobes oblong obtuse or orbicular, striate, puberulous, about half as high as the mature nut; nut globose, apiculate, about 1 cm. diam., sparsely tomentose. (When immature the nut is conical and almost enveloped by the small calyx lobes). *Embryo:* cotyledons erect, unequal, longitudinally striated; dorsal cot. slightly embracing the placental cot. and alone reaching the apex of the ovary; placental cot. smaller; radicle erect, exposed on one side between the lobes of the dorsal cotyledon.

Hopea sangal was first collected by Korthals in about 1840 from Borneo. He gave an excellent description of the field characters of the tree *sangal,* but, being based on limited sterile material, it was hardly adequate from a botanical point of view and led to misinterpretation and confusion by Hance and others with Roxburgh's *Hopea odorata* (1832) from India, to which species *H. sangal* was reduced by Hance in 1876. This reduction appears to have been accepted by all authors, Kurz excepted, for over half a century, and on the strength of it *H. odorata* has been erroneously recorded from Borneo, until in 1927 van Slooten indicated that separation was necessary. During that period or earlier Korthals' plant had been recollected on numerous occasions, referred to various species, and described under a variety of names.

In 1856 Hasskarl founded his new genus *Petalandra* and described his *P. micrantha* from collections from east Java. When Bentham and Hooker [Gen. Plant. I (1862–67) 193] united *Petalandra* Hassk. with *Hopea* Roxb., confusion arose between this species and *Hopea micrantha* Hook. f., (1862) a quite distinct plant. Reference is made to the

* On some collections the receptacles and calyx parts show a tendency to enlarge even before the buds have opened. This is the condition of the flower figured in Plate V, 6*a*, 8*a* and 9*a*.

problem by Hance in Journ. Bot. 5: 308 (1876), by King in Journ. As. Soc. Bengal 62, pt. 2: 126 (1893), and by Heim in Rech. Diptéroc. 64 (1892) who proposed the epithet *Hasskarliana* for Hasskarl's plant, that of Hooker having prior claim to the trivial *micrantha.*

In 1860 Miquel redescribed *H. sangal* from a sterile collection of Teysmann from Bangka as *"Hopea ? fagifolia"* and in 1870 Scheffer referred another collection of Teysmann ("prope Djebœs") to Miquel's species without having seen the type. I have not seen the Djebœs collection and I am in doubt as to whether it was correctly placed by Scheffer.

Scheffer also referred collections of Teysmann from Sumatra to *Hopea diversifolia* Miq. In this he was wrong. *H. diversifolia* Miq. is founded on two collections which I have examined and find to represent two distinct species neither of which is *H. sangal.*

In 1877, when Burck transferred *Petalandra* Hassk. and several species of *Hopea* to *Doona,* he created the combinations *Doona odorata* (under which he retained *H. sangal*) and *Doona micrantha,* and reduced *H. fagifolia* Miq. to the latter species. At the same time he described *H. sangal* yet again from Javanese collections, under the name of *Doona javanica,* a name that was altered by Heim in 1892 to *Hopea javanica* with the transfer of Burck's Malayan species of *Doona* to *Hopea.* In 1899 Bœrlage, and in 1900 Koorders and Valeton, suggested the union of *H. javanica* with *H. fagifolia* Miq. and *Hopea (Petalandra) micrantha.*

The earliest recorded collections of *H. sangal* from the Malay Peninsula were made by Kunstler in Perak (1885) and Curtis in Penang (1888). Upon these collections King founded his *Hopea Curtisii* in 1893.

Another Peninsula collection from Perak was made by Wray jnr. and described by Brandis in 1895 as *Hopea globosa.* At the same time he described two collections, one by Lowe in Borneo and the other by Teysmann in Sumatra, as *Hopea Lowii* using a name given in manuscript by Dyer.

In the Flora of the Malay Peninsula (1922) Ridley referred some additional collections to *H. Curtisii* and *H. globosa* and recorded *H. Lowii* from the Peninsula referring several collections to that species. He mentions, however, that the last two are suspiciously alike.

Foxworthy, in Mal. For. Rec. 10 (1932), referred most of our broad-leaved collections of *H. sangal* to *H. Curtisii;* to *H. globosa* he referred one collection (C. F. 8023), and to *H. Lowii* one collection (Ridley 6585—formerly referred by Ridley to *H. globosa*). As *Hopea multiflora* Foxworthy

described a species closely related to *H. odorata* Roxb. that I am renaming *Hopea semicuneata,* but C. F. 5906 upon which he based the fruit description is *H. sangal,* as also are a number of collections cited under this heading with doubt. The remainder of our collections were cited by Foxworthy under *Hopea albescens. H. albescens* Ridl. is, however, a very distinct plant which I have reduced to *Shorea hopeifolia* (Heim) Sym. and discussed in Gdns. Bull. S. S. 7: 150 (1933).

Two reasons mainly account for the fact that *H. sangal* has been redescribed on so many occasions. The first is the inadequacy of the material upon which early descriptions were based and the second the variation in leaf within the species. The collections upon which King based his *H. Curtisii* and to which Bœrlage gave the manuscript names *Doona micrantha* var. *macrosepala, Hopea macrosepala,* and *Hopea fagifolia* var. *fol. latioribus* are typical of the broad-leaved form represented by a number of our collections, most of which were placed by Foxworthy under the first name. Bœrlage's manuscript species *H. fagifolia* var. *javanica* and our collections placed by Foxworthy under *H. albescens* are representative of the ovate-lanceolate-leaved form. Miquel's *H. fagifolia* and Brandis's *H. globosa* were described from collections of immature leaves probably taken from saplings (the fruits of Wray 816 are not attached to the leaves). All intermediate stages are represented in the collections I have examined and I am unable to recognise any clearly defined divisions within the species although I do not doubt that definable local strains do exist.

Some remarks seem necessary concerning the affinities of *H. sangal. Petalandra micrantha* Hassk., which is here shown to be a synonym of *H. sangal* Korth., was the species upon which Hasskarl founded the genus *Petalandra.* Bentham and Hooker and later authors have maintained *Petalandra* as a section of *Hopea* referring to it those species that differed from the section *Euhopea* in having, *inter alia,* 10 as opposed to 15 stamens. This is a convenient division but I am of opinion that the maintenance of *Petalandra* even as a section tends to obscure natural relationships. I should like to have the support of more detailed study of the anatomy and embryo development before making a final statement, but it seems to me unfortunate that *H. sangal* Korth. and *H. acuminata* Merr. should be separated from such species as *H. odorata* Roxb., *H. Helferi* Brandis (=*H. dealbata* Hance), *H. nutans* Ridl. and *H. semicuneata* Sym. because of a single character—the number of stamens. I have found on several occasions

that in dipterocarps that normally have 15 stamens, one row may abort, or in those that normally have 10, 15 may be present. It would appear therefore that this character should be treated with reserve when considering natural relationships within this family.

Collections examined—

SIAM: C. F. 3761, 3835, 3863 & 3874.

MALAY PENINSULA: KEDAH: C. F. 12220, 17614, 17858, 27061, 27464 & 27472.

PENANG: Curtis 1562 (Auth. spec. of *Hopea Curtisii* King); S'pore 3459, 3473 (H. B. 933.21.5), 3504 (H. B. 933.21.4), 3655, 3715 & 3717; C. F. 28005 (Hort. Penang Tree No. 18) & 28010 (Hort. Penang Tree No. 15).

PERAK: King 8161 (Auth. spec. of *Hopea Curtisii* King); Wray 816 (Auth. spec. of *Hopea globosa* Brandis) & sine no. (Larut); Harun sine no. (1906); C. F. 0118, 8023, 11022, 11590, 13233, 30816, 30913, 31403 & 32261.

KELANTAN: S'pore 24839, C. F. 32733 & 32834.

TRENGGANU: C. F. 26961.

PAHANG: C. F. 1262, 1281, 2754, 4650, 4855, 5160, 5469, 5480 (H. B. 933.21.2 & 7), 6697, 8139, 8887, 10564, 10659, 15147, 15500, 15629, 15714, 15765, 17286, 18653, 18667, 26182, 26501 & 27995.

SELANGOR: Ridley, sine no. (Rantau Panjang); Mat, sine no. (1908); C. F. 8372, 14586, 24906 & 32871.

NEGRI SEMBILAN: Clerk sine no. (1912); C. F. 619, 659, 1886, 1991, 4206 & 20106.

JOHORE: Curtis 3613; C. F. 5906, 5984 & 12058.

SINGAPORE: Ridley 6585.

SUMATRA: Teysmann 12039 (H. B. 933.21.61), 12040 (H. B. 933.21. 59) & 12042 (H. B. 933.21.60) [Auth. specs. of *H. diversifolia* Scheff], & sine no. in Herb. Kew. [Auth. spec. of *H. Lowii* Dyer]; Grashoff 217 (H. B. 933.21.10), 715 (H. B. 933.21.9) & 973 (H. B. 933.21.52); Remoorin sine no. (H. B. 933.21.51); F. R. I. bb. 16395 (H. B. 933.21.68); H. B. 933.21.8.

BANGKA: Teysmann 3236 (H. B. 933.21.16) [Auth. spec. of *H. fagifolia* Miq.]; 1520 (H. B. 933.21.15).

JAVA: Teysmann 12043 (H. B. 933.21.37) [Auth. spec. of *P. micrantha* Hassk.]; Burck sine no. (H. B. 933.19.2; H. A. R. T. 72511) [Auth. spec. of *D. javanica* Burck]; Koorders 1387β (H. B. 933.21.48), 1556β (H. B. 933.21.40), 1647β (H. B. 933.21.47), 10004β (H. B. 933.21.50), 20256β (H. B. 933.21.46), 20326β (H. B. 933.21.41), 23013β (H. B. 933.21.39) & 24792β (H. B.

933.21.49); Uhl 5951 (H. B. 933.21.14 & 44), & 5951*a* (H. B. 933.21.13 & 45); Van Steenis 2419 (H. B. 933.21.43); Kalshoven 33 (H. B. 933. 21.36); Cult. in Hort. Tiekeumeuk—H. B. 933.21.24 (3-B-6); 933.21.56 (4-C-4) & 57 (4-D-4) [*H. fagifolia* var. *fol. latioribus* Bœrl.]; 933.19.1 (5-D-5) [*H. macrosepala* Bœrl. & *D. micrantha* var. *macrosepala* Bœrl.]; 933.21.54 (6-A-6) & 55 (6-D-4) [*H. fagifolia* var. *javanica* Bœrl.]; 933.21.22 & 23; Cult. in Hort. Bog.—H. B. 933.21.18 & 27 (VI-C-222); 933.21.19 (VI-C-222*a*); 933.21.20 & 28 (VII-B-22*a*); 933.21.25 (VII-B-65); 933.21.21 & 26 (VII-2-26*a*); 933.21.29, 30, 31, 32, 33, 34 & 35.

BORNEO: Korthals sine no. (H. B. 933.19.3; H. A. R. T. 72513) [Auth. spec. of *H. sangal* Korth.]; Lowe sine no. in Herb. Kew [Auth. spec. of *H. Lowii* Dyer]; Teysmann 8020 (H. B. 933.21.12); Hallier 1028 (H. B. 933.21.42); Dumont sine no. (H. B. 933.21.11); H. B. 1904 (933.21.17); For. Dept. B. N. B..No. 1234.

LOCALITY UNCERTAIN: H. B. 933.21.33 & 53.

Hopea sangal is quite common in the Peninsula, particularly in the north and in Pahang. It is usually found at low elevations near streams and has a dark, closely fissured bark upon which tears of white opaque damar are common. The most commonly applied vernacular names are *damar mata kuching, chengal pasir* and *mesiput* (Pahang). Collections of this tree from the Malay Peninsula and Islands have formed the types of a number of species which are shown to be synonymous and are united under the oldest name, *Hopea sangal.*

Hopea semicuneata Symington, **sp. nov.:** *Hopea ? diversifolia* Miq., Fl. Ind. Bat. Suppl. 491 (1860) partim: *Hopea* sp., V. Sl. ex Merr., Univ. Calif. Pub. Bot. 15: 202 (1929); *sama rupa chengal,* Foxw., Mal. For. Rec. 3: 71 (1927): *Hopea multiflora* Foxw. Mal. For. Rec. 10: 119 (1932) partim, non Brandis: *Hopea ? plagata* Sym. in Gdns. Bull. S. S. 7 pt. 2: 154 in obs., non Vidal. **Plate VI.**

Hopea odorata Roxb. affinis, petiolis brevioribus, ovario glabro, stylopodio truncato, stylo breviore differt; *H. sangal* Korth. similis, nerviis secondariis foliorum paucioribus, ovario glabro, staminibus 15 pro 10 distinguitur.

Branchlets terete, almost black when dry, puberulous towards the ends. *Leaves** usually oblong lanceolate or ovate lanceolate, apex acuminate, base usually markedly

* The very marked similarity between the leaves of this species and those of *H. plagata* Vidal led me to suggest the possible identity of those species (Symington, l.c.).

unequal, acute or cuneate on one side, obtuse or sub-acute on the other, about 11 cm. × 4.5 cm. but variable, glabrous and usually drying grey-green above, glabrous or sparsely puberulous upon the veins and with a brown tinge beneath; midrib elevate on both surfaces; secondary nerves 8–10 pairs, inconspicuous above, elevate and frequently with barbate domatia in the axes of the lower pairs beneath; tertiary nerves hardly visible on either surface, joining the secondaries in numerous fine more or less parallel lines; petioles rugose, about 1 cm., puberulous, black; stipules caducous (not seen). *Panicles* axillary and terminal, pendulous, racemose, about half as long as the leaves, grey or tawny tomentose; ultimate branches about 4 mm. apart, up to 1.6 cm. long, each bearing 3–9 closely set secund flowers. *Flowers* elliptical or ovate in bud, 3.5 mm. long including the pedicel; pedicel 1 mm., tomentose. *Sepals* imbricate, sub-equal in height; two oval or ovate, thick, tomentose outside and on the upper portion inside; three slightly broader, irregularly oval or rotundate, thinner, tomentose outside only. *Petals* contorted in bud, oblong, fimbriate at the apex, tomentose outside on the portion exposed in bud, pale yellow (M. Haniff, S'p. 3729). *Stamens* 15, in pairs opposite the sepals, solitary opposite the petals, of 3 heights; anthers oval, the posterior cells smaller than the anterior; filaments 2–3 times as long as the anthers, filamentous above, suddenly widening to the broad flattened basal portion; appendage to connective filiform, about twice the length of the anther. *Ovary* broadly cylindrical, slightly constricted before the upper third which may be considered as a stylopodium, flattened at the top where there is a papillose ring, glabrous; style short, cylindrical, glabrous; stigma minute. *Fruit* (immature—C. F. 24644); stalk 1 mm., puberulous; calyx lobes shortly united to form a flat puberulous disc-like receptacle; 2 large calyx lobes oblong spathulate to broadly elliptical, apex rounded, much constricted and puberulous at the base, about 3.5 cm. long and 1–1.8 cm. broad, with 10–12 longitudinal nerves; 3 small lobes deltoid, obtuse, 2.5 mm. × 2.0 mm., puberulous; nut globose, 5 mm. diam., puberulous.

I have given as allies to this species two species, *H. odorata* and *H. sangal*, conventionally considered to belong to different sections of the genus. My reasons for this will be evident from my notes on the affinities of *H. sangal*. *H. semicuneata* is a most interesting species because it supports the argument in favour of the union of the sections *Euhopea* and *Petalandra* by combining characters typical of each. It has the truncate stylopodium of *Petalandra* and the 15 stamens of *Euhopea*.

Collections examined—

MALAY PENINSULA: PENANG: S'p. 3729.

PERAK: C. F. 24644 (Type of young fruit) 25151, 25419, 28589 & 28595.

DINDINGS: C. F. 27838.

PAHANG: C. F. 2729, 4526 (Type of flower), 5440, 6696, 7943, 7947, 24821, 26001, 26002, 26003, 26038, 29554 & 29555.

NEGRI SEMBILAN: C. F. 4403 & 26605.

MALACCA: C. F. 18267 & 18268.

BORNEO: B. N. B.: Elmer 21382.

Hopea semicuneata is the botanical name here given to the tree known in Kinta district, Perak, as *sama rupa chengal.* From parts of Pahang the names *chengal, chengal batu, penak* and *penak batu* have been recorded. The species was described as *H. multiflora* in Mal. For. Rec. 10, where, (p. 120) additional information concerning the field characters may be found. Usually this tree is found upon ridges up to about 1,200′ but I have also found it on the peculiar association on sand, at sea level, at Pasir Panjang in the Dindings. The only Bornean collection known records the tree "in forests along tidal streams."

Balanocarpus Bedd.

The genus *Balanocarpus* was established by Beddome in 1873 upon two species *(B. erosa* and *B. utilis)* from the Tinevelly mountains in southern Madras, that differed from *Hopea* in having a woody nut enclosed in a 5-lobed woody cup. I have not examined any specimen of *B. erosa* but, if the specimens of *B. utilis* kindly lent to me by Mr. Parkinson, may be taken as representative of Beddome's *Balanocarpus,* it may reasonably be doubted whether the creation of a new genus was justified. In my opinion the importance of the nature of the fruiting calyx has been greatly overstressed by systematic workers on the *Dipterocarpaceae.* Thus it is that the genus *Balanocarpus,* originally created for two wing—less species related to *Hopea odorata* Roxb., has become the repository for dipterocarps of very diverse groups that have failed to conform to conventional generic definition by possessing, when in fruit, an accrescent calyx cup none of the lobes of which have developed into wings.

In 1899, Trimen added to the genus *B. zeylanicus* which is possibly most closely related to *Hopea ferrea* Lanessan.

In 1893 King added several others from the Malay Peninsula. *B. Curtisii* King is clearly related to *Hopea myrtifolia* Miq. and *H. bracteata* Burck [=B. bracteatus

(Burck) Merr.*]. *B. penangianus* King [=B. multiflorus (Burck) Sym.] is, as I have stated elsewhere (Gdns. Bull. S. S. 7, pt. 2: 129 & 152), very evidently related to a group of *Shorea* including *S. Faguetiana* Heim and *S. hopeifolia* (Heim) Sym. This relationship was observed by Heim (Recherch. Diptéroc.: 50) when he founded his genus *Richetia* upon *R. coriacea* Heim (=*Balanocarpus coriaceus* Auct.) and three other species now all reduced to *B. multiflorus* (Burck) Sym. *Balanocarpus anomalus* King was evidently placed in this genus at a venture in the absence of fruiting material and has since been reduced by Foxworthy to *Hopea ferrea* Lanessan. *Balanocarpus maximus* King is quite distinct from any of the other species hitherto referred to that genus. Its most close ally appears to be *Balanocarpus longiflorus* (Brandis) Foxw., both of which species appear to be more closely allied to some species in the *Brachyptera* section of *Shorea* than any others. *Balanocarpus Heimii* King is an anomalous species unlike any other to which I have had the opportunity of giving detailed study. It certainly does not appear to be at all close to any other species of *Balanocarpus* and, although its fruits are somewhat akin to those of *Hopea (Pierrea) pachycarpa* (Heim) Sym., it differs in too many respects from that species to be grouped along with it as Heim would have it. *Balanocarpus Wrayi* King was based upon a collection of immature fruit of *B. Heimii* and is no longer upheld as a species.

King's last species, *Balanocarpus Hemsleyanus* was recognised by its author to have affinity with certain species of *Shorea* but was placed in *Balanocarpus* solely on account of its fruit. Foxworthy is undoubtedly correct in placing this species in the *Brachyptera* section of *Shorea*.

In 1918 Foxworthy added two Philippine species to the genus *Balanocarpus*. *B. brachypterus* is clearly a close relative of *B. Curtisii* King which, as I have indicated above, should naturally be included in a group of *Hopea* containing *H. myrtifolia* Miq. and *H. bracteata* Burck. *B. cagayanensis* Foxw. was unlike any *Balanocarpus* then described, but again, the character of wingless fruit was allowed to overshadow the fact that the flowers are almost identical with those of *Hopea philippinensis* Dyer and the many other characters that these species have in common. *Hopea philippinensis* Dyer, usually referred to the *Euhopea* section of *Hopea*, I consider to belong to a group apart which I shall call the *Pierrea* group because *Hopea (Pierrea) pachycarpa*

* *B. Curtisii* King has been united with *H. bracteata* Burck by Merrill [Journ. Str. Br. R. As. Soc. special no.: 407 (1921)], a union which I venture to question.

(Heim) Sym. is one of its members (*vide* my notes on *H. pachycarpa*, p. 30).

Ridley made further additions to the genus. In 1920 he added *Balanocarpus ovalifolius*, described from one flowering and one sterile sheet from Penang. The first is clearly *Hopea intermedia* King (?=*H. Beccariana* Burck) and the second is *Shorea Maxwelliana* King. In 1922 Ridley added *B. pubescens* which so closely resembles *Hopea pachycarpa* (Heim) Sym. that careful study is required to separate them. This clearly should be included in the *Pierrea* group.

The most recent additions to *Balanocarpus* have been made by Foxworthy who, in 1932, described as *B. pahangensis* a plant clearly related to *B. multiflorus* (Burck) Sym. which, as I have stated, would be most happily placed along with *S. Faguetiana* Heim in *Shorea*. At the same time Foxworthy described as *B. ovalifolius* a plant, distinct from Ridley's *B. ovalifolius*, but almost indistinguishable from *B. brachypterus* Foxw.

I have not yet had the opportunity of examining authentic material of *Balanocarpus sphaerocarpus* Heim, *B. bancanus* Bœrl., nor *B. sibogae* Bœrl., all very imperfectly known species, but sufficient has been said to indicate that the disruption of the genus *Balanocarpus* is imminent and that it will be possible to distribute its members among various groups of *Hopea* and *Shorea*.

I am inclined to think that the work of Heim in his "Recherches" sometimes shows a keener appreciation of the natural grouping of the species usually relegated to the genus *Balanocarpus* than does that of his critics. It is, however, undoubtedly true that Heim's excessive subdivision was premature and, as Burkill [Journ. R. As. Soc. Mal. Br. 3: 6 (1925)] has remarked, his work "needed, and still needs much further prosecution in order to establish it". Trimen, King, Brandis, and Foxworthy, who have contributed largely to the motley collection of species now included in *Balanocarpus*, have all expressed dissatisfaction with the genus. Handicapped by the inadequacy of their material as they so often were, they were probably wise to leave the disruption of the genus until more complete material was available.

Of recent years, not only has herbarium material of the *Dipterocarpaceae* accumulated rapidly, but many of the species formerly known only from an incomplete herbarium sheet, are now known intimately as jungle trees. The suggestions I have made above are prompted mainly by the examination of external morphological characters of old and recent material but have not a little support from anatomical

data and from observations in the field. When this has been supplemented and the careful work on the embryo and seedling development carried out by Burkill has been correlated with these observations, then the suggested change may be executed, but meanwhile it seems desirable to maintain the polymorphous genus *Balanocarpus* provided it is recognised as merely a temporary arrangement of convenience.

Balanocarpus longiflorus (Brandis) Foxw., MS., **comb. nov.**: *Hopea longiflora* Brandis in Journ. Linn. Soc. 31: 63 (1895): *Balanocarpus grandifolius* Ridl. MSS. in Herb. Kew. **Plate VII.**

As Brandis's description is rather brief and was based on flowering material only I have prepared the following with the additional help of Igon 00342 and Richards 2441.

Branchlets pale or reddish-brown, coarsely lenticellate, puberulous when young. *Leaves* narrow oblong—lanceolate or long lanceolate tapering gradually from near the base to the acuminate apex, base rounded or sub-cordate, usually about 24 cm. × 4.5 cm. but sometimes proportionately broader, margins revolute, glabrous on both surfaces, dull olive green above, shining yellow-brown beneath, very coriaceous; midrib depressed above; secondary nerves 12–15 prs., very conspicuous on the lower surface; reticulations fine, inconspicuous above, distinct beneath; petioles sulcate, rugulose, puberulous, black, about 1.3 cm.; stipules caducous, not seen. *Panicles* axillary, glabrous, dark-coloured, 1 or 2 main branches irregularly racemose, ultimate branchlets with 1–5 unilateral flowers. *Flowers* elongate pointed in bud, over 1 cm. long including the pedicel (1.7 cm. in Hav. 2120); pedicel 2 mm. long, glabrous or sparsely puberulous. *Sepals* sub-equal (3 inner slightly broader than the 2 outer) deltoid obtuse or broadly ovate acute, glabrous or sparsely puberulous. *Petals* much contorted in bud, linear, slightly fimbriate along the inner margin, puberulous along the outer portion exposed in bud, "brownish purple" (Richards). *Stamens* 15, pairs alternating with single stamens, of 3 sizes; anthers oval; filaments linear, flattened, broader at the base, several times longer than the anthers; appendage to connective filiform, 1–2 times as long as the anther, erect in bud, later becoming deflexed with the anthers. *Ovary* globose, glabrous, surmounted by an elongate-conic stylopodium which tapers gradually into the glabrous style; stigma minute, obscurely 3-lobed. *Fruit:* sub-sessile; receptacle woody, glabrous; calyx lobes equal, embracing the lower portion of the nut but quite free from it, deltoid, obtuse, 8 mm. high, papyraceous above, thickened below,

striated, glabrous; nut long elliptic, sharp pointed at apex, 6 cm. × 1.7 cm., glabrous.

The earliest collections of this species examined by me are Haviland 2120 and 2254 from Kuching. Upon the former, which bore fully expanded flowers, Brandis based his *Hopea longiflora* in 1895. The latter has young flower buds and has been given the MS. name of *Balanocarpus grandifolius* by Mr. Ridley. In the absence of fruit and with the limited knowledge of the systematic groups within the *Dipterocarpaceae* then possible, Brandis placed the species in the *Euhopea* section of *Hopea*. In 1926 a fruiting collection (00342) was made in Setapok F. R., Sarawak, by Dr. Foxworthy's collector. A sheet of this was examined by Foxworthy who identified it with *Hopea longiflora* Brandis and suggested the transference to the genus *Balanocarpus*.

The genus *Balanocarpus* of King, Brandis and others is not a natural genus [*vide* my notes under *Balanocarpus* (p. 26)], and I am therefore reluctant to add yet another species to so heterogeneous a group, but until the classification of the species in all genera concerned is revised upon a more natural basis efforts must be concentrated upon grouping together those species that are clearly related to one another. Of the species examined by me *Balanocarpus maximus* King appears to be the closest relative of *Hopea longiflorus* which is therefore transferred to the genus *Balanocarpus*. Whether these species should remain generically distinct from *Shorea macrantha* Brandis, *S. Hemsleyana* King and some other species in the *Brachyptera* section of *Shorea* is a question upon which I am not yet prepared to give an opinion.

Collections examined—

SARAWAK: Haviland 2120 (Auth. spec. of *H. longiflora* Brandis) & 2254 (auth. spec. of *B. grandifolius* Ridl. MS.); Foxworthy's No. (Igon) 00342.
P. W. Richards 2441; Gunong Balapau, Ulu Tinjar, c. 800–900 m., primary forest; 2nd Nov. 1932; flower. Field note—"*Medang tiong*. Tree 26.7 m. high. Calyx greenish yellow; corolla lobes brownish purple".

Hopea pachycarpa (Heim) Symington, **comb. nov.**: *Pierrea pachycarpa* Heim in Bull. Soc. Linn. Paris 2: 958 (1891) et Recherch. Diptéroc. 78 (1892) Pl. 7; Brandis in Journ. Linn. Soc. 31: 113 (1895) in nota; Merr. in Journ. Str. Br. R. As. Soc. special no. 408 (1921); Gilg. in Nat. Pflanzenfam. 2nd edit. 21: 263 (1925) in nota: *Pierreocarpus pachycarpa* Ridl., MSS. in Herb. Kew. **Plate VIII.**

Branchlets pale tawny tomentose with decurrent elevate lines. *Leaves* elliptic-oblong or oblong—lanceolate, gradually tapering to the long acuminate apex, base slightly unequal, usually rounded on sub-cordate on one side, acute on the other, sub-revolute, about 15–20 cm. × 4–7 cm., glabrous except for the midrib and secondary nerves, drying a milk-chocolate colour on both surfaces or slightly glaucescent beneath; midrib strongly elevate and tomentose above, slightly elevate and puberulous beneath; secondary nerves 10–14 prs. at an angle of 45° to the midrib, slightly depressed and puberulous above, strongly elevate and fugaceous tomentose beneath; tertiary nerves joining the secondaries in numerous more or less parallel lines, hardly distinguishable on either surface; petioles about 0.7 cm., thick, rugulose, tawny tomentose; stipules caducous (not seen). *Panicles* of 2–3 racemes fascicled in the leaf axes; racemes 3–4 cm. long, black, glabrous, lax; ultimate branchlets about 6 mm. apart, subtended by minute deltoid caducous stipular bracts, each bearing 3–4 sub-secund flowers about 5 mm. apart subtended by caducous bracteoles. *Flowers* oval in bud, 4.5 mm. long including the pedicel; pedicel 1 mm. long, glabrous, minutely papillose. *Sepals* sub-equal in size; 2 ovate, rounded or apiculate at apex, thick, glabrous, 3 oval or rotundate, obtuse mucronate at apex, thinner, minutely ciliate along the upper margin, otherwise glabrous. *Petals* slightly contorted in bud, oblong, erose at the top and along one margin, tomentose along one half outside. *Stamens* 15, pairs alternating with single stamens; anthers oval, the posterior cells slightly smaller than the anterior; filaments 2–3 times as long as the anthers, broad and flattened below, gradually narrowing to the filamentous upper portion; appendage to connective filiform, about the same length as the filament. *Ovary* with stylopodium shaped like an hour glass, glabrous; stylopodium puncticulate above; style short glabrous; stigma minute, obscurely lobed. *Fruit* (mature): stalk hardly protruding from the concavity of the enlarged sepal bases, thick, 2 mm. long, glabrous; receptacle and accrescent calyx lobes thick, woody, glabrous, black, united together and to the nut by a resinous cement, forming a 5-lobed cupule, about 2 cm. high × 1.7 cm. broad; nut ovate-conical, mucronate, glabrous, shining, covered with a pale yellow resinous coating; pericarp woody, thickened in the apical portion and splitting readily into 3 equal portions to one of which the placenta is attached. *Embryo:* cotyledons collateral, the dorsal exceeding the placental and alone reaching the apex of the ovary, markedly lobed; radicle medial, erect, directed into the apex of the ovary.

Pierrea pachycarpa was described by Heim from a single specimen with immature unfertile fruit (Becc. 3314) and made the type of a new genus *Pierrea*. The inadequacy of the material for the foundation of a new genus is, of course, obvious, and no published information has since been added to our knowledge of the species except that Brandis remarked that it "seems to stand nearest to *Balanocarpus* and *Shorea*".

The first and only known flowering collection of this species is Haviland 2251*. This was identified with Heim's plant by Mr. Ridley who proposed (MSS. in Herb. Kew) to rename the genus *Pierreocarpus*, *Pierrea* Heim being invalidated by the earlier homonym *Pierrea* Hance (1877), now reduced to a section of *Homalium* Jacq.

A sheet of Hav. 2251 from the Kuching Museum, in a better state of preservation than the Kew sheet, has enabled me to give a description of the inflorescence and flowers, while Igon (Foxworthy's collector) No. 00207 has provided excellent material with mature fertile fruits.

The assignation of this plant to the genus *Hopea* requires some explanation. *Pierrea pachycarpa* Heim belongs to a group of dipterocarps including the following:—*Hopea philippinensis* Dyer (1878), *Hopea mindanensis* Foxw. (1911), *Balanocarpus cagayanensis* Foxw. (1918), *Balanocarpus pubescens* Ridl. (1922), probably *Hopea papuana* Diels (1922)†, and *Hopea laxa* Sym. (1934). These form an essentially homogeneous group with tomentose branchlets, slightly inæquilateral leaves, pronounced secondary nerves joined by numerous obscure tertiaries, flowers in solitary or fascicled glabrous racemose panicles, sepals nearly glabrous, petals erose at the apex, 15 stamens with broad filament bases and long filiform appendages, glabrous ovaries shaped somewhat like an hour glass, and minute stigmas. The fruits are apparently more diverse, those of the species referred to *Hopea* having two calyx lobes developed into wings, those relegated to *Balanocarpus* (as *Pierrea pachycarpa* itself) having no such wings. The nut of all species is, however, essentially the same. The lower portion is enclosed in the thickened sepal bases which are closely appressed to it. The pericarp is hard and woody, very thick in the apical portion, and splits readily along three lines of weakness into three equal portions, to one of which the placenta is attached. The cotyledons are erect and collateral, the dorsal is slightly

* The Kew sheet bears young fruits and flowers that are detached from the leaves; the sheet in the Kuching museum has no fruits but the flowers are attached.

† *Hopea papuana* Diels is known to me only from a drawing of the type kindly communicated to me by Dr. van Slooten.

larger than the placental, and the radicle is medially placed and directed into the apex of the ovary.

The first of the above species to be described was *H. philippinensis* Dyer. Certainly this plant has sufficient in common with *H. odorata* Roxb. and its closest allies to justify its inclusion in the genus *Hopea* but I would not include it in the section *Euhopea* as Heim, Brandis and others have done. I prefer to consider it along with the species listed above as belonging to a distinct *"Pierrea"* group (*vide* my notes on *Balanocarpus*, p. 26). To this group *Hopea pachycarpa* (Heim.) Sym. belongs.

Collections examined—

SARAWAK: Becc. 3314 (Auth. spec. of *Pierrea pachycarpa* Heim.); Haviland 2251; Foxworthy's No. (Igon) 00207.

Hopea laxa Symington, **sp. nov. Plate IX.**

Affinis *H. pachycarpa* (Heim) Symington sed foliis majoribus multinerviis, paniculis longioribus laxioribus, pedicellis longioribus differt.

Branchlets pale tawny tomentose with decurrent lines elevate for 1–2 cm. *Leaves* oblong or elliptical—oblong, gradually tapering to the acute apex, base slightly unequal, rounded on one side and sub-acute on the other, slightly revolute, about 27 cm. × 8 cm., glabrous, pale yellow-brown or with a green tinge on both surfaces and sometimes glaucescent beneath (v.s.); midrib elevate on both surfaces; secondary nerves 13–17 prs. at an angle of 45° to the midrib, slightly depressed above, with traces of barbate domatia in their axes beneath; tertiary nerves fine and parallel, numerous, distinguishable only on the under surface; petioles 1.2 cm., thick rugulose, tawny tomentose; stipules linear sub-falcate, 5 mm. long, puberulous, persistent. *Panicles* of 2–3 racemes fascicled in the leaf axes; racemes up to 18 cm. long, black, glabrous, lax; ultimate branchlets 2 cm. apart, subtended by sub-falcate tomentose stipular bracts of which the lower sometimes persist; each bearing 4–5 flowers 1 cm. apart, arranged spirally or tending to be secund and subtended by caducous bracteoles. *Flowers* ovate in bud, 8 mm. long including the pedicel; pedicel 2 mm. long, glabrous, sparsely papillose. *Sepals* sub-equal in size and shape, ovate-deltoid, obtuse, the inner three sparsely ciliate along the apical margin, otherwise glabrous. *Petals* slightly contorted in bud, oblong, erose at the top and along one margin, tomentose along one half outside. *Stamens* 15, pairs alternating with single stamens; anthers oval, the posterior cells slightly smaller than the anterior; filaments 1–2 times as long as the anthers, broad and flattened below,

narrowing abruptly to the filamentous upper portion; appendage to connective filiform, as long as or longer than the filament. *Ovary* with stylopodium shaped somewhat like an hour glass, glabrous; stylopodium puncticulate above; style short. glabrous; stigma minute, obscurely 3–lobed. *Fruit* unknown.

Hopea laxa belongs to a group of *Hopea* which I have called the "*Pierrea*" group (*vide* this paper pp. 27 & 32). *Hopea pachycarpa* (Heim) Sym. seems to be its closest relative but it has much in common with all the members of the *Pierrea* group.

Being known from flowering material only, it is not possible to predict with absolute certainty the form of the fruits of this species, because some of its nearest relatives in the *Pierrea* group have fruits of the two–winged *Hopea* type while others have fruits of the wingless *Balanocarpus* type. The very slight differentiation of its sepals in flower, however, indicates that the fruits will probably be of the latter type. The species of this group producing fruits of the *Hopea* type, that I have examined, may be detected by a marked dissimilarity in the sepals even in bud.

Collections examined—

SARAWAK: P. W. Richards No. 2361 (Type of *H. laxa* Sym.); Dulit, under 300 m.; 29th Oct. 1932; flower. Field Note—*Medang kuning*. Crest of ridge, primary forest. Tree, 24 m. high, 5 cm. (?) diam. Traces of buttresses".

Hopea sp.

P. W. Richards No. 1836; Ulu Koyan, c. 900 m., white sand ("heath") forest; Sept. 15th, 1932; young fruit. Field note—"*Luis bukit.* Fruit deep crimson. Tree, 30 cm. diam. No buttresses. Bark reddish, smooth, without fissures. c. 20–25 m. high. Timber used."

This collection, which bears very young fruit, is clearly of a species of *Hopea* belonging to the section *Dryobalanoides*. I am of opinion that it represents an undescribed species but owing to the limited material and the fact that diagnostic characters within this section are so difficult to define, it seems prudent to await further collections before attempting to describe a new species.

In leaf Richards 1836 is very close to collections of *Hopea Pierrei* Hance from Cambodia and I should be sorely tempted to refer it to that species were it not that the fruit appears to have a slightly longer pedicel and that to find this species in Borneo would be surprising. Brandis and others do actually record *H. Pierrei* from Borneo, but this is on the strength of the misidentification by Brandis of

Beccari 2504 and 3050 which are, I consider, *H. Dyeri* Heim. With this exception no dipterocarp has as yet been recorded from both Indo-China and Borneo.

Vatica dulitensis Symington, **sp. nov. Plate X.**

V. pallida Dyer et *V. albiramis* V. Sl. similis sed foliis lanceolatis acuminatis, laciniis calycis fructiferi omnino reflexis quam nuce multo longioribus distinguenda.

Branchlets glabrous, grey-brown, becoming dark ferruginous puberulous towards the ends. *Leaves* lanceolate acuminate, base rounded, usually about 8 cm. × 2 cm. but may be up to 10 cm. × 3.5 cm., glabrous, when dry shining light red-brown or greenish yellow above, paler and dull beneath; midrib slightly elevate above, strongly elevate and pale yellow beneath; secondary nerves about 14 pairs, at an angle of 45° to the midrib, yellow beneath, with frequent short intermediary nerves and reticulations conspicuous on both surfaces; petioles 0.8 cm., puberulous, black; stipules minute, caducous. *Panicles* terminal and axillary (rarely extra-axillary), branching irregularly from the base, up to 5 cm. long, minutely ferruginous tomentose; ultimate branchlets up to 1.5 cm. long, each bearing 2–5 spirally arranged flowers 1.0–2.0 mm. apart. *Flowers* oblong in bud, 8 mm. long including the pedicel; pedicel 2 mm., ferruginous stellate tomentose. *Calyx cup* less than 1 mm. high; lobes apparently valvate, equal, deltoid, obtuse, 0.6 mm. long, tomentose outside, puberulous inside. *Petals* hardly contorted in bud, oblong, rounded at apex, tomentose outside except at base, puberulous on the upper half inside, "creamy white" (Richards, 1343). *Stamens* 15, in pairs opposite the sepals, solitary opposite the petals; filaments short, very broad and flattened at the base; anthers almost as short, posterior cells much smaller than the anterior; appendage to connective conical, blunt. *Ovary* sub-globose, stellate tomentose; style about as long as the ovary, glabrous; stigma, a smooth conical crown consisting of 3 conical lobes. *Fruit* (nearly mature?): stalk 6 mm. long, puberulous; receptacle thin, disc-like, not enclosing the nut; accrescent calyx lobes reflexed and curved, sub-equal, elliptical or elliptic-oblong, obtuse, about 2.2 cm. × 0.8 cm., fugacious ferruginous tomentose, with 5 inconspicuous longitudinal nerves, "greenish-yellow, suffused with brown" (Richards); nut globular, apiculate, 0.5 cm. diam., ferruginous tomentose, obscurely marked with 3 lines—probably the lines of cleavage on germination of the fruit.

Vatica dulitensis belongs to the sub-genus *Isauxis* (Arn.) Brandis. It seems to me to have more in common with *V. pallida* and *V. albiramis* than other species on

account of the curved and reflexed fruiting calyx lobes, but its fruits are quite distinct from any hitherto described.

Collections examined—

SARAWAK: *P. W. Richards No. 1343;* Dulit, under 300 m.; Aug. 19th, 1932; flower. Field note—"*Resak tiong* or *resak bukit.* Primary forest on summit of steep-sided ridge. Tree, 87 ft. high, diam. 15". Almost unbuttressed. Bark smooth with a few narrow longitudinal splits, ¾" thick. Wood yellowish. Corolla creamy white. Peduncles reddish brown. Fruit R. 2543. Fls. with sickly sweet scent. Timber useful. Resin when kept for some months used for torches".

Native Collector No. 2543; Dulit, under 300 m.; Nov. 10th, 1932; fruit. Field note—"*Resak tiong* or *resak bukit.* Primary forest. Tree 11.7 m. high, 24 cm. diam. Wings of fruit greenish—yellow, suffused with brown, reflexed. Fruit of same species as an earlier number (1343) from neighbouring tree".

Cotylelobium flavum Pierre, Fl. For. Cochinch., t. 258A (1891); V. Sl. in Bull. Jard. Bot. Buitenz. III, 12, pt. 1: 44 (1932); *Cotylelobium asperum* V. Sl. in l.c. III, 10: 401, fig. 3 (1930).

P. W. Richards No. 2715; Gunong Santubong (1st Division), c. 300 m., low rain forest on rocky mountain side; Dec. 1932; young fruit. Field note—"Fallen branch from tree, probably of moderate size. Fruit pale green, wings bright crimson. Leaves coriaceous, yellow brown beneath."

Distribution—Borneo.

C. flavum has been reported from the Malay Peninsula by Brandis, Ridley, van Slooten, and others as a result of the misidentification of Ridley 4630 and other collections of *C. malayanum* V. Sl. Van Slooten corrected the error in January 1932 after study of the type material concerned, but later Foxworthy (Mal. For. Rec. 10: 246) again recorded the species from the Peninsula on the evidence of four collections from Kuala Kemaman. I am of opinion that these collections also are *C. malayanum* and that there is no evidence of the occurrence of *C. flavum* Pierre outside Borneo.

Corrigenda

Notes on Malayan Dipterocarpaceae I [Gdns. Bull. S. S. Vol. VII, pt. 2 (1933)].

p. 133—C. F. 27801 cited under *Shorea platycarpa* Heim is *S. palembanica* Miq. and should be inserted after C. F. 5696 on p. 142.

p. 150—Under *Shorea hopeifolia* (Heim) Sym. add the typonym *Hopea hopeifolia* V. Sl. in Bull. Jard. Bot. Buitenz. III, X, 3: 396 (1929).

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Names of groups especially dealt with in this paper are shown in **heavy type** and synonyms are printed in *italics*.

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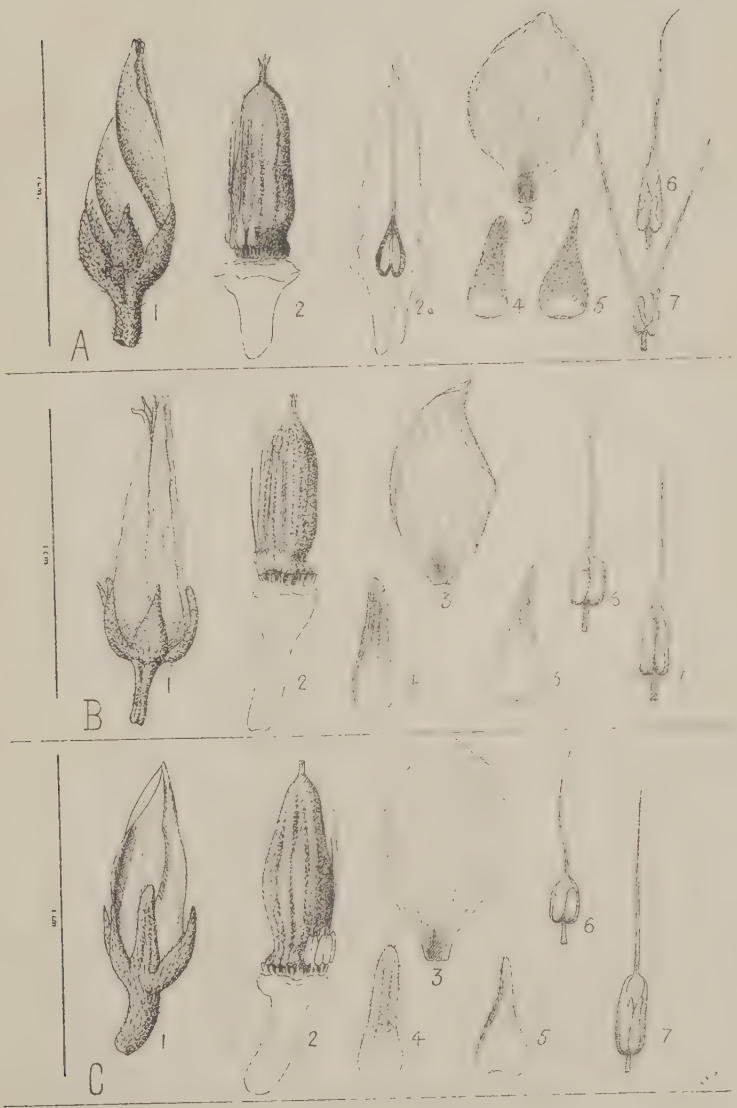
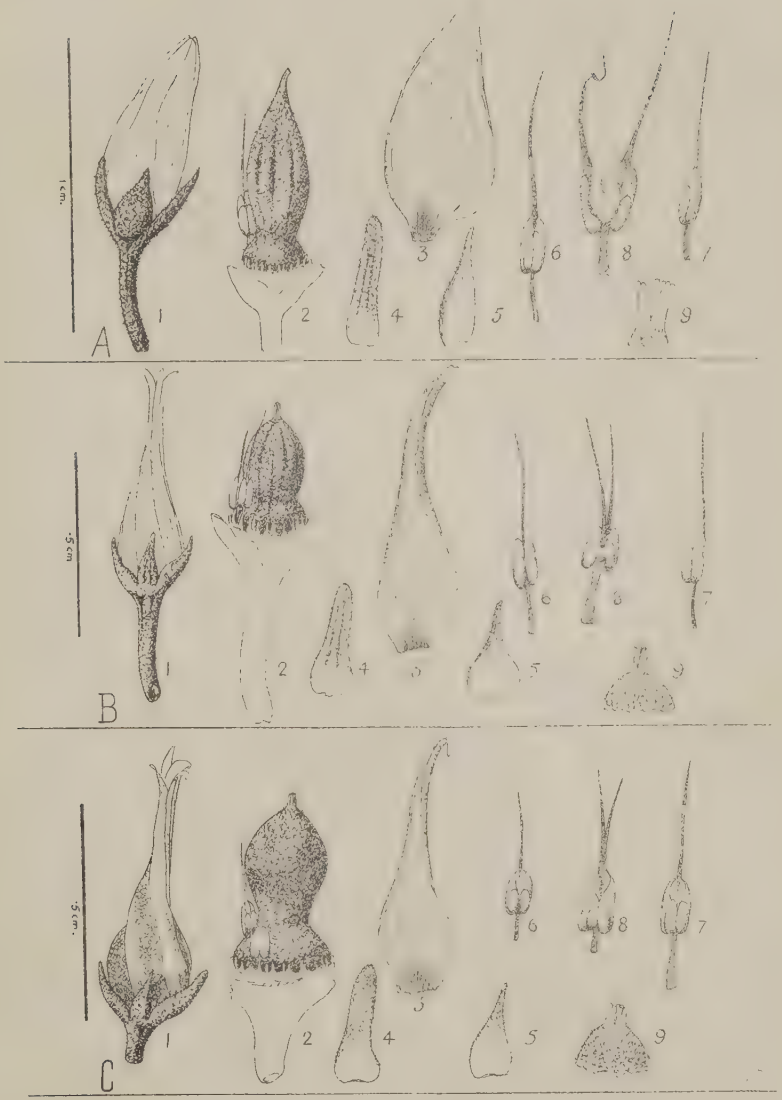
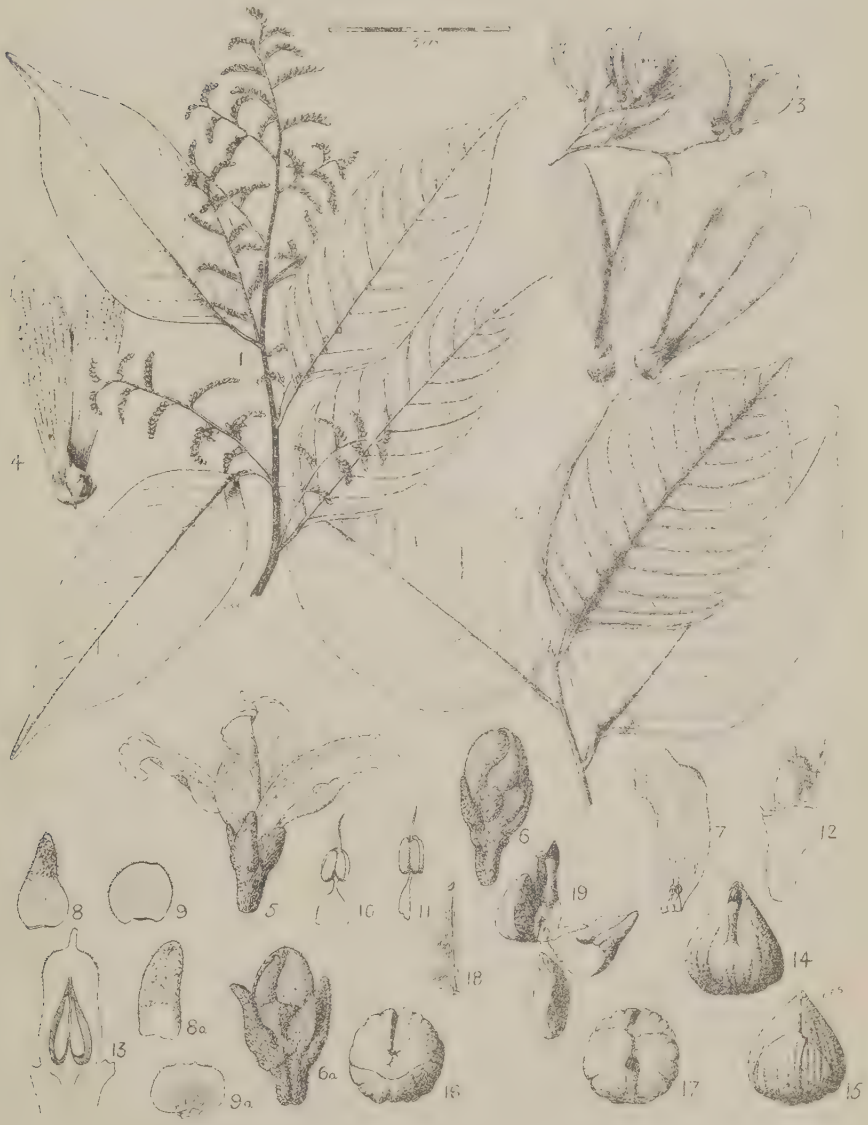


A. Anisoptera costata, Korth., B. Anisoptera oblonga, Dyer, C. Anisoptera marginata, Korth.



A. Anisoptera megistocarpa, V. SI., B. Anisoptera Curtisii, Dyer, C. Anisoptera thurifera (Blco.) Bl.



Hopea sangal, Korth.

Hopea semicuneata, Sym.

Balanocarpus longiflorus (Brandis) Foxw.

Hopea pachycarpa (Heim) Sym.

Hopea laxa, Sym.

Vatica dulitensis, Sym.

EXPLANATION OF PLATES

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Plate II. **Anisoptera laevis** Ridl. 1, flowering twig. 2, ripe fruit. 3, fruit with cotyledons exposed 4, flower bud. 5, flower bud—petals removed. 6, flower bud—petals and anthers removed. 7 & 8, sepals from mature flower. 9, petal from expanded flower. 10 & 11, stamens from expanded flower. 12, stigma. 13 & 14, stigma dissected. (drawings based on C.F. 647) *Scale applies to* 1 & 2 *only*.

Plate III. A. **Anisoptera costata** Korth. (drawings based on F.R.I. No. T. 896). B. **Anisoptera oblonga** Dyer (drawings based on C.F. 30133). C. **Anisoptera marginata** Korth. (drawings based on Herb. Bog. Cult. IX-D-171). 1, flower buds about to open. 2, 1 with perianth parts removed. 2a, section thro' ovary and stylopodium. 3, petals from expanded flowers. 4, large sepals. 5, small sepals. 6 & 7, stamens (7a=abnormal double stamen). *Scales apply to* 1 *only*.

Plate IV. A. **Anisoptera megistocarpa** V. Sl. (drawings based on C.F. 624). B. **Anisoptera Curtisii** Dyer (drawings based on C.F. 11662). C. **Anisoptera thurifera** (Blco.) Bl. (drawings based on For. Bur. Phil. 707). 1, mature flower buds. 2, 1 with perianth parts removed. 3, petals from 1. 4, large sepals. 5, small sepals. 6 & 7, stamens. 8, abnormal double stamens. 9, styles. *Scales apply to* 10 *only*.

Plate V. **Hopea sangal** Korth. 1, flowering twig. 2, twig with fruit almost mature. 3, immature fruit. 4, mature fruit. 5, expanded flower. 6 & 6a, flower buds. 7, petal from expanded flower. 8 & 8a, large sepals. 9 & 9a, small sepals. 10 & 11, stamens. 12, ovary & stylopodium. 13, section thro' ovary & stylopodium. 14, embryo—dorsal view. 15, embryo—placental view. 16, embryo from below. 17, embryo from above. 18, placenta. 19, embryo—one lobe of each cotyledon detached. (Drawings 1 & 5—13 based on C.F. 15147; 2 based on S'p. 3473; 3 based on C.F. 26501; 4 based on Wray 816; 6a, 8a & 9a based on H.B. 5951; 14—19 based on C.F. sine no.) *Scale applies to* 1—4 *only*.

Plate VI. **Hopea semicuneata** Symington. 1, flowering twig. 2, twig from seedling. 3, immature fruit. 4 & 5, fruit more mature than 3. 6, expanded flower. 7, flower bud. 8 & 9, outer sepals. 10, 11 & 12, inner sepals. 13 & 14, petal from bud. 15 & 16, stamens. 17, ovary & stylopodium. 18, section thro' ovary & stylopodium. (Drawings 1 & 6—18 based on C.F. 4526; 2—5 based on C.F. 24644). *Scale applies to* 1—5 *only*.

Plate VII. **Balanocarpus longiflorus** (Brandis) Foxw. 1, flowering twig. 2, ripe fruit. 3, flower bud. 4, expanded flower. 5, ovary. 6, 7 & 8, sepals. 9, petal from expanded flower. 10 & 11, stamens from bud. 12 & 13, stamens from expanded flowers. (Flower drawings based on Hav. 2120 & Rich. 2441; fruit on Igon 00342.) *Scale applies to* 1 & 2 *only*.

Plate VIII. **Hopea pachycarpa** (Heim) Symington. 1, flowering twig. 2, mature fruits. 3, immature fruit. 4, mature fruit—resinous coating removed. 5 & 6, nut from mature fruit. 7 & 8, embryo. 9, embryo—one lobe of each cotyledon removed. 10, flower bud. 11 & 12, petals. 13 & 14, outer sepals. 15, 16 & 17, inner sepals. 18 & 19, stamens. 20, flower bud—sepals & petals removed. 21, ovary. 22, section through ovary. (Drawings of twig & flower parts based on Hav. 2251; fruit & embryo based on Igon 00207). *Scale applies to* 1—5 *only*.

Plate IX. **Hopea laxa** Symington. 1, flowering twig. 2, flower bud. 3, expanded flower. 4, inner sepal. 5, outer sepal. 6 & 7, petal from bud. 8 & 9, stamens. 10, flower—sepals & petals removed. 11, ovary & stylopodium. 12, stigma. (Drawings based on Richards 2361). *Scale applies to* 1 *only*.

Plate X. **Vatica dulitensis** Symington. 1, flowering twig. 2, twig with fruit almost mature. 3, expanded flower. 4, flower bud. 5, flower bud—petals removed. 6, sepals. 7 & 8, petals from expanded flower. 9 & 10, stamens from flower bud. 11, anther from mature flower. 12, stigmatic parts removed from the sheath-like style. 13, nut—embryo exposed. 14, embryo. (Drawings of flower parts based on Richards 2543). *Scale applies to* 1 & 2 *only*.

THE GENUS SELAGINELLA IN THE MALAY PENINSULA

By A. H. G. Alston, British Museum (Natural History).

Only one account of the Selaginellas of the Peninsula has yet been published, that of H. N. Ridley in Journ. R. Asiatic Soc., Straits Branch, no. 80 (1919). Thirty-seven species were enumerated there, a number which is now reduced to twenty-five. In this paper the view is taken that the species shew a considerable range of variation, especially in the size of the leaves. The shape and marginal cilia of the leaves are, however, relatively constant.

S. Ridleyi Bak., *S. rivalis* Ridl., *S. cuprea* Ridl., *S. alutacia* Spring and *S. Morgani* Zeiller are apparently endemic, though the last two species are closely related to species from the Archipelago.

Thanks are due to the authorities at Kew, Singapore, Paris, Leyden, Edinburgh and Brussels for the loan of specimens. The following abbreviations are used to indicate the herbaria in which the specimens are located. BM=British Museum (Natural History), B=Jardin Botanique, Brussels, E=Royal Botanic Gardens, Edinburgh, G=Conservatoire Botanique, Geneva, K=Royal Botanic Gardens, Kew, L=Rijks Herbarium, Leyden, P=Museum d'Histoire Naturelle, Paris, S=Botanic Gardens, Singapore.

The dates of the publications on the voyages of Bélanger, d'Urville, Duperry and Freycinet have been adapted from a paper by Sherborn and Woodward in Ann. Mag. Nat. Hist. ser. 7, VII, pp. 388-392 (1901).

Sporophylls uniform:
- Main stems creeping rooting at intervals:
  - Lateral leaves entire or subentire: 1. S. Mayeri
  - Lateral leaves ciliate:
    - Lateral leaves usually strigose on the upper surface, rarely overlapping: 4. S. strigosa
    - Lateral leaves glabrous, overlapping:
      - Lateral leaves rounded at apex:
        - Median leaves strongly ciliate 2. S. Ridleyi
        - Median leaves ciliolate 3. S. rivalis
      - Lateral leaves subacute at apex 15. S. atroviridis
- Main stems rooting in the lower half:
  - Main stems scandent; leaves entire; steles 3 or more:
    - Axillary leaves small, oblong-lanceolate; all leaves iridescent 7. S. Willdenowii
    - Axillary leaves large, orbicular 8. S. padangensis
  - Main stems erect or suberect:
    - Lateral leaves at base of main stem distant, erect adpressed, usually uniform:

- Lateral leaves entire:
  - Axillary leaves large, overlapping branches:
    - Strobili usually 2-3-nate; axillary leaves not auricled — 9. S. polystachya
    - Strobili solitary; axillary leaves strongly auricled — 10. S. plana
  - Axillary leaves not overlapping branches; strobili solitary; axillary leaves at most slightly auricled:
    - Pinnæ ovate; pinnulæ distant — 11. S. delicatula
    - Pinnæ lanceolate; pinnulae crowded, usually simple — 12. S. Wallichii
- Lateral leaves ciliate or ciliolate:
  - Median leaves margined: — 13. S. argentea
  - Median leaves not margined:
    - Upper margin of lateral leaves not auriculate — 14. S. peltata
    - Upper margin of older lateral leaves auriculate — 15. S. frondosa

Lateral leaves of main stem spreading, strongly dimorphous, usually crowded:

- Median leaves acuminate, white margined; lateral leaves ovate-lanceolate — 6. S. repanda
- Median leaves usually long mucronate;
  - Lateral leaves ovate-lanceolate; stems often stoloniferous: — 5. S. selangorensis
  - Lateral leaves oblong-lanceolate, entire or ciliolate:
    - Stems stoloniferous — 16. S. Griffithii
    - Stems never stoloniferous:
      - Lateral leaves strongly ciliate and enlarged at base — 17. S. Roxburghii
      - Lateral leaves entire to ciliolate-dentate:
        - Lateral branches 1-2 forked — 18. S. ascendens
        - Lateral branches pinnate:
          - Lateral leaves slightly decurrent at base, entire — 19. S. cuprea
          - Lateral leaves rounded at base; denticulate — 20. S. atroviridis

Sporophylls dimorphous:

- Stems prostrate:
  - Lateral leaves denticulate — 21. S. minutifolia
  - Lateral leaves ciliate at base:
    - Median leaves ciliolate; median leaves ½ length of lateral leaves — 22. S. alutacia
    - Median leaves entire or denticulate; median leaves 2/3 length of lateral leaves — 23. S. ciliaris
- Stems erect or suberect:
  - Lateral leaves broadly ovate — 24. S. Morgani
  - Lateral leaves oblong-lanceolate — 25. S. ornata

1. **S. Mayeri** Hieron. in Engl. u. Prantl., Nat. Pfl. I, 4, p. 700, no. 343 (1901).

S. calcarea Ridl. in Journ. R. As. Soc., Str. Br., no. 80, p. 149, no. 4 (1919).

S. merguina "Spring"; Ridl. l.c. p. 149, no. 7.

?S. semicordata (Wall.) Spring in Mart. Fl. Bras. I, 2, p. 122 (1840).

?S. Mettenii A. Br. App. Ind. Sem. H. Berol. 1867, p.l.

S. Schildei Hieron. ex. v.A.v.R. Mal. Fern Allies p. 198 (1915); Mal. Ferns and Fern Allies. Suppl. I, Corr. p. 38 (1917).

S. speluncae v.A.v.R. in Bull. Jard. Bot. Buit., ser. 3, V. p. 229 (1922).

SINGAPORE: *Mayer* 532 (K.); Tanglin Barracks, *Ridley* 5830 (BM.).

PAHANG: Telom, *Ridley* 13987 (BM.K.); Gua Tipus, *Henderson* 22552 (BM.); Kuala Bertam, on rock, *Kiah* 23953 (BM.); Gunong Senyum, on bare limestone rock, c. 400 ft., *Henderson* 22230 (BM.); Tembeling, *Holttum* 24728 (BM.); limestone country near Chigar Perah, *Henderson* (BM.); Gunong Senyum, *Henderson* 22322 (BM.).

SELANGOR: Klang Gates, *Ridley* 13444 (K.), 13443 (BM.K.); Bukit Kayu Kapun, *Ridley* 10634 (K.); Batu Caves, *Ridley* 13445 (K.); Gua Batu, *Ridley* 8772 (K.), 8151 (BM.K.); Ginting Peras, *Ridley* 7827 (K.); Ulu Gombak, *Ridley* (K.); Caves, Kuala Lumpur, *Ridley* 1680 (BM.K.), 1697 (BM.). Bukit Hitam, *Ridley* 7816 (K.); Rawang, *Ridley* 7820 (K.).

PERAK: Temengoh, *Ridley* 14474 (K.); Taiping Hills, *Ridley* 11472 (K.); Tanjong Malim, *Ridley* 11857 (K.).

KELANTAN: Kuala Aring, *Yapp* 75 (K.); Sungei Keteh, Batu Papan, *Md. Nur* 12081 (BM.).

PENANG: Stone Quarry, Chetty Temple, *Curtis* (S.K.); Waterfall, *Curtis* 1736 (S.K.).

NEGRI SEMBILAN: Bukit Tangga pass, *Ridley* (K.).

Geographical Range: Burma, Sumatra.

There is a fragment of Mayer's type in Hb. Kew. *S. calcarea* Ridl., from Batu Caves (*Ridley* 8772), appears to be only a small state of this species. *S. Mettenii* A. Br., described from plants growing in the Leipzic Botanic Gardens is very similar but has narrower lateral leaves. *S. semicordata* (Wall.) Spring, originally described from Nepal, is also closely allied but is rather smaller. Probably they are only forms of this species, but more material is required from India for certainty.

The Bukit Timah locality given by Ridley must be a mistake as Ridley 8151 has two labels in Hb. Kew, in Hb. Mus. Brit. it is labelled "Gua Batu Woods" only.

This seems to be a limestone species.

2. **S. Ridleyi** Bak. in Ann. Bot. VIII, p. 131, no. 58 (1894); Ridl. in Journ. R. As. Soc., Str. Br., No. 80, p. 148, no. 1 (1919).

MALACCA: Gunong Mering, Mt. Ophir, on rocks in stream, *Ridley* 3346 (K. type; BM.).

Geographical Range: Endemic.

3. **S. rivalis** Ridl. in Kew Bull. 1924, p. 266.

SELANGOR: Ulu Gombak, *Ridley* (K. type, BM.).

PAHANG: Kuala Teku, *Seimund* 417 (S.).

PENANG: Government Hill, *Ridley* (BM.).

Geographical Range: Endemic.

4. **S. strigosa** Bedd. in Kew Bull. 1911, p. 192, No. 600; Ridl. in Journ. R. As. Soc., Str. Br., No. 80, p. 149 (1919).

SELANGOR: Klang Gates, *Ridley* 13442 (BM.K.), 13446 (BM.K.); Ginting Bidai, *Ridley* 7815 (K.), 7825 (K.).

Geographical Range: Endemic.

Hairs on the surface of the leaves are very rare in Selaginellæ and are only found in *S. hispida* (Willd.) A. Br., *S. trachyphylla* A. Br., *S. Lindenii* Spring, *S. scabrida* Ridl., besides this species. It is probable that it is not always a good character and that this is a form of *S. selangorensis* Bedd.

5. **S. selangorensis** Bedd. ex Ridl. in Journ R. As. Soc., Str. Br., No. 80, p. 148, no. 3 (1919).

S. microdendron Ridl. l.c. p. 150, no. 9 non Bak. (1885).

SELANGOR: Semangkok Pass, *Ridley* 12040 (type K.).

PAHANG: Sungei Tahan, nr. Kuala Teku, 500 ft., on rock by river, *Holttum* 20800 (S.).

PENANG: Penang Hill, *Ridley* 7085 (K.); Western Hill, 2,500 ft. on wet rock, *Holttum* 19312 (K.).

var. **ciliata** var. nov.

Foliis lateralibus latioribus, basi longe ciliatis.

PERAK: Taiping Hills, *Ridley* 14463 (BM. type, K.).

KEDAH: Kedah peak, *Ridley* 5174 (K.), 3,000 ft., *Robinson & Kloss* 6097 (K.).

Geographical Range: Endemic.

6. **S. repanda** (Desv.) Spring in Gaudich, Voy. Bonite Bot. I, p. 329 (1844–6).

Lycopodium repandum Desv. ex Poir Encycl. Suppl. III, p. 558 (1814).

L. barbatum Kaulf. Enum. Fil. p. 18 (1824).

Selaginella barbata (Kaulf.) Spring in Bull. Acad. Brux. X, p. 226, no. 101 (1843).

L. tetragonostachyum Wall. Cat. no. 124 (1829) nomen; Hk. & Grev. in Hk. Bot. Misc. II, p. 398, no 129 (1931).

S. tetragonostachya (Wall.) Spring in Bull. Acad. Brux. X, p. 234, no. 163 (1843).

S. plumosa forma *tetragonostachya* (Wall.) Haines Bot. Bih. & Or. p. 1224 (1924).

L. tetragonostachyum major Hk. & Gr. in Hk. Bot. Misc. II, p. 389 (1831).

S. pyrrhopus Spring Monogr. II, in Mem. Ac. Belg. XXIV, p. 114, 115 (1850) in syn. sub *S. radicata suberecta* Spring.

Lycopodioides barbatum (Kaulf.) O. Ktze. Rev. Gen. p. 826 (1891).

L. suberectum (Bak.) O. Ktze. l.c. p. 827.

MALACCA: *Griffith* (K. type of S. *suberecta* Bak.).

PENANG: *Lowe* (E.).

PERLIS: *Ridley* 14770 (S.).

Geographical Range: Philippines, Formosa, Siam, India, Java, Sumbava, and Timor.

Lycopodium repandum was described from Philippine material by Desvaux. It was reduced to *L. barbatum* Kaulf., by Sprengel, Syst. Veg. IV, p. 17 (1827), who was followed by Spring, and re-examination of the type in Hb. Paris confirmed this identification. The type of *L. barbatum* was collected in the Philippines by Chamisso. *L. tetragonostachyum* Wall. was collected in Burma by Wallich, while the var. *major* was described from three collections. *S. radicata suberecta* was based on several Indian specimens. *S. plumosa Hamiltonii* Bak., was based on *S. semicordata* J. Scott (non Spring).

7. **S. Willdenovii** (Desv.) Bak. in Gard. Chron. 1867, pp. 783, 950.

Lycopodium Willdenovii Desv. ex Poir, Encycl. Suppl. III, pp. 540, 552, no. 87 (1814).

L. caespitosum Blume Enum. Pl. Jav. II, p. 270, no. 23 (1830).

S. caespitosa (Blume) Spring in Bull. Ac. Brux. X, p .140, no. 33 (1843).

S. Willdenowii Linden Cat. No. 8, p. 15 (1853) nomen.

Lycopodioides Willdenowii (Desv.) O. Ktze. Rev. Gen. p. 827 (1891).

Lycopodium laevigatum Willd. Sp. Pl. V, p. 45, no. 66 (1810) non Lamk. (1791).

Selaginella laevigata (Willd.) Spring in Mart. Fl. Bras. I, 2, p. 125, no. 13. (1840) non Baker (1867).

S. caesia arborea Hort. Angl. ex Kunze Ind. Fil. p. 124 (1856).

S. uncinata arborea Mett. Fil. Hort. Lips. p. 124 (1856).

S. altissima Kl. ex [W. Lauche] Verz. August. Garten p. 8 (1856) nomen.

S. arborea Hort.; Dippel in Amtl. Ber. Deutsch Naturf. XXXIX, p. 145 (1865).

S. arborescens Hort.; Russow in Mém. Ac. Imp. Pétersb., sér. 7, XIX, p. 176 (1873).

S. Willdenowii caesia arborea (Hort) Hieron. ex. R. Bonap. Notes Pterid. II, p. 30 (1915).

S. Willdenowii forma *typica* v.A.v.R. Mal. Ferns and Fern Allies Suppl. I, Corr. p. 40 (1917).

"Common all over open country, forest edges and cleared spaces in forest"—Ridley l.c. p. 155.

Geographical Range: Sunda Is. and Indo-China.

S. caespitosa (Bl.) Spring is a monstrous state of the "witch's-broom" type; it is found in Java;—*Zollinger* 81A (L.), Salak, *Blume* (L.). Sumatra:—Palembang, *Praetorus* (L.). There is an unlocalised specimen from Malaya (*Yapp* 45) in Hb. Kew shewing both forms on the same stem. Similar formations are found on *S. Vonroemeri* v.A.v.R. from New Guinea collected by *Kloss* (BM.) *S. pentagona* Spring from the Khasia Hills (*Griffith*, K.), *S. Parkeri* (Hk. & Gr.) Spring (*Leng* 196; *Jenman*) and an unidentified species from the Solomon Islands at Kew. A witch's broom found on *S. monospora* Spring in Sikkim (*Anderson* 1404, *Gamble* 8004, *Clarke* 27401 and *Treutler*) has been described as a new species *S. microclada Bak.* These formations are probably due to a fungus.

8. **S. padangensis** Hieron. in Hedw. L. p. 34, no. 23 (1910).

S. inaequalifolia "Spring"; Ridl. in Journ. R. As. Soc., Str. Br., no. 80, p. 154, no. 19 (1919).

S. caudata "Spring"; Ridl. l.c. p. 155, no. 22.

SELANGOR: Ginting Simpah, *Hume* 9386 (S.).

PAHANG: Tembeling, *Holttum*, 24696 (BM.).

KELANTAN: Sungei Keteh, Batu Papan, *Md. Nur* 12079 (BM.).

PERAK: Temengoh, *Ridley* 14467 (BM.); Goping, *King's Collector* 474 (K.); Telok Pinang, nr. Ipoh, *Ridley* 9570 (K.); Chanderiang, *King's Collector* 5781 (K.).

Geographical Range: Sumatra.

The Sumatra specimens have slightly broader bracts but do not appear to differ otherwise. *S. inaequalifolia* appears to be confined to the hills of Assam and South India.

9. **S. polystachya** (Warb.) Hieron. in Engl. u. Prantl. Nat. Pfl., I. 4, p. 702, No. 362 (1901).

S. Wallichii polystachya Warb. in Monsunia I, p. 106 (1900).

S. permutata Hieron. in Hedw. L. p. 24, no. 19 (1910).

S. illustris Ridl. in Journ. R. As. Soc., Str. Br., No. 80, p. 154, no. 18 (1919).

NEGRI SEMBILAN: Bukit Tangga, *Ridley* (K.); Gunong Angsi, *Md. Nur* 1536 (K.BM.), *Winkler* 1772 (BM.).

SELANGOR: Semangkok, *Ridley* 8772 (K.); Sempang, *Ridley* 15630 (K.); Ginting Simpak, 1,500 ft., *Hume* 8850 (S.); Ginting Bidai, *Ridley* 7819 (K.); Semangkok Pass, *Ridley* (K.).

PAHANG: Tahan River, *Ridley* 2172 (BM.K.); Sungei Cheka, *Holttum* 24770 (BM.).

KELANTAN: Pasir Depok, *Haniff and Nur* 10212 (K.); Kuala Aring, *Yapp* 29 (K.).

PERAK: Gunong Kerbau, *Robinson* 3500 (K.); Goping, *King's Collector* 516 (K.); Temengoh, *Ridley* 14467 (K.), 14459 (BM.).

var. ?

Plant more slender; stem leaves smaller, often spreading; spikes usually solitary.

PAHANG: Gunong Tahan, *Wray & Robinson* 5414 (BM.K.); Kuala Teku, *Seimund* (K.).

SELANGOR: Cheras, *Ridley* 8195 (K.); Kanching, *Ridley* (K.).

PERAK: Batang Padang, *King's Collector* 7764 (K.).

Geographical Range: Sumatra.

This species is probably the same as *S. stipulata* (Bl.) Spring. *S. Kittyae* v.A.v.R. and *S. axillifolia* v.A.v.R. are also very close.

10. **S. plana** (Desv.) Hieron. in Engl. u. Prantl. Nat. Pfl. I, 4, p. 703, no. 363 (1901).

Lycopodium planum Desv. ex Poir. Encycl. Suppl. III, p. 554, no. 98 (1814).

L. Durvillaei Bory in Duperry Voy. Bot. t. 25 (1829) excl. descr.

S. perelegans Moore in Gard. Chron. XI, p. 533 (1879).

JOHORE: Pulau Aor, *Henderson* 18365 (BM).

Geographical Range: Sumatra, Java, Timor, Amboina, Bauda, Ceram, and Bouru.

Commonly cultivated in most tropical countries and found as an escape in Trinidad.

Bory's plate of *L. Durvillaei* was drawn from La Billardière's Amboina specimen and represents this species; the Rawak specimen collected by Gaudichaud is *S. Pouzolziana* (Gaud.) Spring and the one from Port Praslin, collected by Burville is the species to which the name *S. Durvillaei* (Bory) A. Br. is usually applied. The dates of publication are in Ann. Mag. Nat. Hist., ser. 7, VII, p. 392.

11. **S. delicatula** (Desv.) Alston in Journ. Bot. LXX, p. 282 (1932).

Lycopodium delicatulum Desv. ex Poir. Encycl. Suppl. III, p. 554, no. 99 (1814).

Selaginella Pouzolziana (Gaudich.) Spring in Bull. Ac. Brux. X. p. 145 (1843); Warb. Monsunia I, p. 121 (1900).

Lycopodium Pouzolzianum Gaudich. in Freyc. Voy. Bot. I, p. 257 (1828).

S. canaliculata Baker in Journ. Bot. XXIII, p. 21 (1885) pp. excl. syn. Linn.

S. flaccida (Bory) Spring in Bull. Ac. Brux. X, p. 145, no. 77 (1843).

L. flaccidum Bory in Bél. Voy. Bot. II, p. 9 (1834).

Lycopodioides flaccidum (Bory) O. Ktze. Rev. Gen. p. 826 (1891).

Lycopodium curvatum Dalz. in Hk. Kew Gard. Misc. IV, p. 114 (1852) non Sw. (1801).

Selaginella semicordata "Spring"; Ridl. in Journ. R. As. Soc., Str. Br., no. 59, p. 234 (1911).

Lycopodium crassicaule Hk. & Gr. Enum. Fil., in Hk. Bot. Misc. II, p. 382, no. 101 (1831).

Selaginella crassicaulis (Hk. & Gr.) Spring in Bull. Ac. Brux. X, p. 232, no. 139 (1843).

S. suberosa "Spring"; Ridl. in Journ. R. As. Soc., Str. Br., no. 80, p. 160, no. 36 (1919) pp.

PENANG: Stone Quarry, Chitty Temple, *Curtis* 3380 (S.K.).

KELANTAN: Kwala Krai, *Haniff and Nur* 10123 (BM.K.); Bank of Kelantan R. nr. Chaning, *Ridley* (K.).

PERAK: Temengoh, *Ridley* 14467 (K.).

KEDAH: Bukit Wang, in Kedah, *Haniff* 1202 (S.); near Kampong Naka, c. 100 ft., *Holttum* 19834 (BM.).

PERLIS: Bukit Ketri, on dry rocks, *Henderson* 23116 (BM.); Besih Hangat, in half shade amongst rocks, *Henderson* 22873 (BM.); nr. Kanga, *Ridley* (S.).

LANGKAWI IS.: *Ridley* 8322 (S.K.); Gunong Raya, *Ridley* 15547 (S.K.), *Haniff & Nur* 7156 (K.).

Geographical Range: Moluccas, S. China, Siam, India.

12. S. **Wallichii** (Hk. & Gr.) Spring in Mart. Fl. Bras. I, 2, p. 124 (1840).

Lycopodium Wallichii Hk. & Gr. in Hk. Bot. Misc. II, p. 384, no. 106 (1831).

L. elegans Wall. List p. 6 no. 128 (1829) nomen, non Desv.

Lycopodioides elegans (Wall.) O. Ktze. Rev. Gen. I, p. 825 (1891).

S. Wallichii elegans (Wall.) Warb. in Monsunia I, p. 106 (1900).

S. cyatheoides Spring in Bull. Ac. Brux. X, p. 145, no. 76 (1843) pp.

Lycopodium mimosoides Roxb. in Cat. l.c. Journ. Nat. Hist. IV, p. 473 no. 7 (1844).

S. Wallichii Walkeri v.A.v.R. in Bull. Jard. Bot. Buit., ser. 2, XVI, p. 51 (1914).

SINGAPORE: *Wallich* (K.), *Norris* (K.), *Cantley* (BM.), *Walker* 24 (BM.).

JOHORE: Castlewood, *Ridley* 12224 (K.); Batu Pahat, *Ridley* 11062 (K.).

MALACCA: *Maingay* 1835 (K.); *Cuming* 2398 (BM.K.); shady jungles, *Pinwill* (K.).

NEGRI SEMBILAN: Perhentian Tinggi, *Ridley* 9869 (K).

SELANGOR: Sungei Buloh, *Burkill* 11870 (BM.K.); Ginting Sempah, *Ridley, Robinson & Kloss* (K.); Ulu Gombak, *Ridley* (K.); Fraser Hill, on ground in jungle, *Burkill & Holttum* 8819 (K.) Gua Batu, *Ridley* 8134 (K.), Ulu Langat, *Kloss* (BM.).

TRENGGANU: Kuala Berang, in shade near stream, *Holttum* 15324, a branched form (K.).

KELANTAN: Sungei Keteh, *Md. Nur* 12094 (K.); Chaning woods, *Ridley* (K.). Kota Bahru, in Rahmar jungle. *Gwynne-Vaughan* 550, branched form (K.).

PERAK: Goping, *King's Collector* 561 (K.); Hill Garden, Larut, *Wray* 23, branched form, (K.); Taiping, *Hervey* (BM.); Temengoh, *Ridley* 14450 (BM.); Bukit Rengas, *Fox* (BM.).

PENANG: Hills of Penang, *Lobb* 160 (K.), 2,000 ft., Lobb (BM.); Ara Kuda, *Ridley* 6860 (BM. K.); Penang Bukit, *Curtis* 3058 (K.); Penang, *Wallich* 128 pp. (BM.K.), *Dalhousie* (K.), *Curtis* (BM.), *Birch* (BM.).

Geographical Range: Indo-China, Sumatra.

S. Hookeri Bak., from Assam, should probably be regarded as a variety of this species; its lateral branches are usually bipinnate and the axillary leaves imbricate over the branchlets. *S. mcgalura* Hieron, (*S. bidiensis Hieron.*), from Borneo, is also closely allied but the ultimate branches taper below the cones, which are usually in pairs.

The variety *Walkeri* has rather larger ultimate pinnules and slightly differently sculptured spores; it does not seem worth distinction.

Roxburgh's specimens of *L. mimosoides* Roxb. in Hb. Mus. Brit. are labelled "Ind. Orient"; they were probably collected at Penang.

13. **S. argentea** (Wall.) Spring in Bull. Ac. Brux. X, p. 137, no. 14 (1843); Ridl. in Journ. R.A.S., Str. Br., no. 80, p. 155, no. 21 (1919).

Lycopodium argenteum Wall. Cat. no. 127 (1829) nomen; Hk. & Gr. in Hk. Bot. Misc. II, p. 384 (1831).

Selaginella caulescens argentea (Wall.) Bak. in Journ. Bot. XXIII, p. 24 (1885); Curtis in Journ. R. A. S., Str. Br., no. 25, p. 97 (1894).

S. trinervia "Spring" fide Hieron. in Hedw. L. p. 15 (1910).

PENANG: *Lady Dalhousie* 96 (K), *Pinwill* (K.) *Maingay* 3216 (K.); Penang Waterfall, *Curtis* 3059 (K.); *Norris* (K.); Penang Hill, *Ridley* 7083 (BM.K.), 7635 (BM.), *Wallich* 127 (BM.) Penang Island, *Wallich* 127 (K.).

PAHANG: Tanjong Antan, *Ridley* 2166 (BM.).

Geographical Range: Siam.

The type of this species is represented by syn-types in Hb. Kew (ex Hb. Hooker) and Hb. Edinburgh (Ex Hb. Greville) with duplicates in Hb. Wallich (at Kew) and Hb. Mus. Brit.

S. argentea (Wall.) Spring is distinguished from *S. caulescens* (Wall.) Spring by its larger size, white-margined median leaves, ciliolate lateral leaves and distant stem leaves.

Hieronymus appears to be mistaken in referring *S. trinervia* to this species as neither the specimens nor the description agree with it.

14. **Selaginella peltata** Presl, in Abh. Bohm. Ges. Wiss., ser. 5, III, p. 582 (1844).

Selaginella bellula Ces. in Atti della R. Acad. Sc. VII, no. 8, p. 36 (1876).

S. involvens bellula (Ces.) Hieron. in Hedw. L, p. 4 (1910).

PERAK: Jor, *Haniff* 14214 (K.).

Geographical Range: Sumatra, Java, Borneo, Philippines.

The type of *S. bellula* collected in Sarawak by Beccari, and presumably in the Florence Herbarium, has not been examined. This species is separated from *S. caulescens* (Wall.) Spring by its larger size and distant stem leaves.

15. **S. frondosa** Warb. in Monsunia I, pp. 105, 117, No. 75 (1900).

S. nutans Warb. l.c. pp. 105, 117, no. 72 (1900).

S. flabellata "Spring"; Ridl. in Journ. R.A.S., Str. Br., no. 80, p. 154, no. 24 (1919).

JOHORE: Ulu Kahang, 400 ft., *Holttum* 10928 (K.); Kota Tinggi, *Ridley* 4140 (BM).

PAHANG: Sungei Cheka, *Holttum* 24772 (BM.); Kota Glanggi, on dry jungle path, *Henderson* 22496 (BM.); west of Joara Bay, P. Tioman, *Burkill* 1138 (S.).

PERAK: Kamuning, *Curtis* 3309 (K.), Goping, *Kunstler* 558 (K.); Ulu Selama, *Wray* 4156 (S.); Tapah, *Wray* 1761 (S.).

KELANTAN: Sungei Galas at Gua Musang, *Henderson* 22602 (BM.), Chaning Woods, *Ridley* (K.).

Geographical Range: Java, Sumatra, and Nicobar Is.

There is a fragment of the type of *S. nutans* Warb. "Java. ex Hb. Hillebrand" at Kew.

S. flabellata (Linn.) Spring, to which Ridley referred most of this material, is a West Indian species.

16. **S. Griffithii** Spring in Bull. Ac. Brux. X, p. 145, no. 80 (1843).

S. merguina Spring in Mem. Ac. Bel. XXIV, p. 81 (1850).

LANGKAWI Is.: Gunong Raya, *Haniff & Nur* 7191 (K.).

Geographical Range: Burma, and Lower Siam.

17. **S. Roxburghii** (Hk. & Gr.) Spring in Bull. Ac. Brux. X, p. 228, no. 115 (1843).

Lycopodium Roxburghii Hk. & Gr. in Hk. Bot. Misc. II, p. 390, no. 135 (1831).

Selaginella acutangula Spring in Mem. Ac. Belg. XXIV, p. 206, no. 144 (1850).

Lycopodioides acutangulum (Spring) O. Ktze. Rev. Gen. I, p. 825 (1891).

S. trichobasis Bak. in Journ. Bot. XXII, p. 275, no. 152 (1884).

S. trichobasis strigosa Ridl. in Journ. R. As. Soc., Str. Br., no. 80, p. 153 (1919).

S. plumea trichobasis (Bak.) v.A.v.R. Mal. Fern Allies p. 102 (1915).

S. lankawiensis Ridl. in Journ. R. As. Soc., Str. Br., no. 80, p. 150, no. 10 (1919).

S. simalurana v.A.v.R. in Bull. Jard. Bot. Buit., ser. 3, III, p. 176 (1920).

S. langirensis v.A.v.R. in Bull. Jard. Bot. Buit., ser. 2, XI, p. 26 (1913).

SINGAPORE: *Norris* (K.); *Walker* 307 (K.); Bukit Timah, *Ridley* (BM.K.).

JOHORE: Marius *Jensen* (K.); Gunong Blumut, *Holttum* 10674 (BM.K.); Mt. Austin, *Ridley* 12570 (K.); Gunong Pulai, *Ridley* 12130 (K.); *Ridley* 12134 (K.); Castlewood, *Ridley* 9192 (K.); Patani Batu Pahat, *Ridley* 10984 (K.); Kluang, *Holttum* 9238 (S.).

SELANGOR: Semangkok Pass, *Ridley* 12041 (K.); Batang Berjuntai, *Ridley* 7828 (K.), 15 miles Pahang Track. *Ridley* 8668 (K.), 8771 (K.); Klang water catchment forest *Burkill* 6824 (S.), *Burkill and Holttum* 9043 (K.); Rantau Panjang, *Kloss* 68 (K.); Kuala Lumpur, *Hose* 361 (K.); Weld's Hill, *Ridley* (K.); Forest Reserve, Rawang, *Kloss* (K.); Batang Padang, *Murdoch* 11963 (K.); Ginting Bidai, *Ridley* 7826 (K.); Batang Berjuntai F. R., *Hume* 7448 (K.); Semenyih, *Hume* 8272 pp. (S.); Ginting Simpak, 1,500 ft., *Hume* 9733, 9879 (BM.).

PAHANG: Wray's Camp, Gunong Tahan, *Ridley* (K.); Telom, *Ridley* 13989 (K.); Kuala Lipis, *Machado* 11588 (K.); Rumpin River, *Evans* (K.); Gunong Raja, *Best* 13856 (S.); Gunong Tahan, *Robinson & Kloss* 5361 (BM.); Sungei

Sat, *Henderson* 22023 (BM.); Sungei Telom, *Kiah and Strugnell* 23989 (BM.); Kuala Lipis, *Burkill* 15674 (BM.); Sungei Cheka, *Holttum* 24771 (BM.), 24769 (BM.).

TRENGGANU: Bundi, *Rostado* 11977 (K.).

DINDINGS: Tanjong Hanka, *Ridley* 7273 (K.).

PERAK: Grik, *Ridley* 14466 (BM.K.); Temengoh, *Ridley* 14457 (BM.), 14470 (K.); Tapah, *Ridley* 14022 (BM.K.); Taiping, *Ridley* 14456 (BM.), 14450 (K.); Jor Camp, *Henderson* 10868 (S.).

KELANTAN: Kuala Aring, *Yapp* 35 (K.).

PENANG: *Lobb* (BM.); *Wallich* 120 pp., *Lady Dalhousie* (K.), *Low* (E.); Penang Hill, *Ridley* 14150 (K.), 14159 (BM.K.); Richmond Pool, *Ridley* (K.); West Hill, *Ridley* (BM.); Pinara Bukit, *Curtis* (S.).

Geographical Range: Siam, Sumatra.

The type of this species has not been found, but there is a specimen labelled *L. Roxburghii* "Penang—Capt. Low 1831" by Greville in Herb. Edinb. and in Hb. Wallich there is a specimen labelled "Lycopodium plumosum 122—i Roxb." which is probably a duplicate of the type.

There is a galled specimen in Hb. Kew (*Ridley* 605) from Bukit Timah.

A similar gall has been seen on a specimen from Indo-China, collected by *Kloss* (BM.). *S. pentagona* Spring collected by *Griffith* in the Khasia Hills (K.), Garo Hills, *Mann* 65 (BM.) and Assam, *Mrs. Hopkinson* (BM.) referred to in Notes Pterid. XI, p. 35, is galled by a gnat (Cecidomyidæ). The gall on *S. pentagona* has been figured in Gœbel's Organographie ed. 2, fig. 418.

18. **S. ascendens** v.A.v.R. in Bull. Jard. Bot. Buit., ser, 2. XI, p. 33 (1913); l.c. XXIII, p. 23 (1916).

SINGAPORE: *Kehding* 3264 (B.).

SELANGOR: 15th mile Pahang Track, *Ridley* 8770 (BM.K.).

Geographical Range: Borneo, Sumatra, Anamba Is.

19. **Selaginella cuprea** Ridley in Journ. R. As. Soc., Str. Br., no. 80, p. 152, no. 14 (1919), excl. var. *major*.

SELANGOR: Rawang, *Ridley* 7822 (BM.K.).

PAHANG: near Chigar Perah, *Henderson* 19490B (BM.K.); Wray's Camp, Gunong Tahan, *Ridley* 16198 (BM.K.); Sungei Cheka, *Holttum* 24778 (BM.); River Tahan, *Ridley* 2177 (BM.).

KELANTAN: Kwala Pertang, *Haniff and Nur* 10377 (BM.K.).

PERAK: Bujong Malacca, *Curtis* 3377 (K.), *Ridley* 9574 (K.).

Geographical Range: Endemic.

The var. *major* seems to be a small form of *S. atroviridis.*

20. **S. atro-viridis** (Wall.) Spring in Flora XXI, p. 183 (1838).

S. trinervia Spring in Bull. Acad. Brux. X, p. 143. no. 62 (1843).

S. plumosa Spring in Mem. Ac. Belg. XXIV, p. 136, no. 81 (1850).

Lycopodium furcatum Roxb. in Calc. Journ. Nat. Hist. IV, p. 475 (1844).

L. atro-viride Wall. Cat. p. 6 no. 120 (1829) nomen; Hk. & Gr. Ic. Fil. 1, t. 39 (1831); in Hk. Bot. Misc. II, p. 387, no. 121 (1831).

"Common in woods"—Ridley l.c. p. 153.

SINGAPORE: *Ridley* 2410 (BM.), 56 (BM.), 2411 (BM.) *Gaudichaud* 13 (P.G.), *Murton* 103 (K.), *Norris* (K.), *King's Collector* 343 (K.).

JOHORE: *Ridley* (BM.), 1347 (K.), 11494 (K.), 11113 (K.), *Jensen* 84 (K.), *Nur & Kiah* 7797 (K.).

MALACCA: *Lobb* (K.), *Griffith* (K.), *Hervey* (K.).

NEGRI SEMBILAN: Winkler 1771 (BM.K.); *Ridley* (K.), *Kloss* (K.), *Nur* (K).

SELANGOR: *Ridley* (BM.), 8669 (K.); Klang, Hullett (S.); Ginting Simpah, *Hume* 9603 (S.), 8837 (S.); Semenyih, *Hume* 8111 (S.).

PAHANG: *Wray & Robinson* 5366 (BM.); *Holttum* 20095 (BM.); *Henderson* 22509 (BM.); *Evans* (K.); *Burkill & Holttum* (K.); *Ridley* 16197 (K.); 16196 (K.).

PERAK: *Ridley* 9571 (K.); *Curtis* 3310 (K.).

TRENGGANU: *Rostado* 11976 (K.).

PROVINCE WELLESLEY: *Ridley* 12635 (K.).

PENANG: *Dalhousie* (K.); *Robinson* (K.); *Macher* (K.); *Birch* (BM.); *Pinwill* (K.); *Ridley* (K.); *Maingay* 2211 (K.); *Curtis* (K.BM.); *Low* 31 (K.); *Wallich* (BM.); *Hall* (BM.).

LANGKAWI IS: *Robinson* 6270 (K.).

Geographical Range: Sumatra, Lower Siam, and Tenasserim.

S. atro-viridis is a very variable species. The following represent varieties, some of which, on further study, may prove to be specifically distinct.

(*a*) *S. atro-viridis* var. *ciliata* Spring.

A variety with ciliolate external leaves.

MALACCA: *Griffith* (K.).

(*b*) A luxuriant form with a thick stem and long aristate median leaves, possibly representing a distinct species.

PAHANG: Telom. *Ridley* 13993 (BM.), 13989 (K.).

PENANG: Penang Hill, *Fox* 10662 (BM.).

PERAK: Taiping, *Hervey* 1667 (BM.).

(*c*) *S. cuprea* var. *major* Ridl.

This seems to be a small form of *S. atroviridis;* the leaves of many species vary greatly in size.

SELANGOR: Bukit Hitam, *Ridley* 7817 (K.).

PAHANG: Bukit Chemaga, *Henderson* 19480A (BM.K.); Wray's Camp, Gunong Tahan, *Ridley* 16199 (K.).

DINDINGS: Telok Sera, *Ridley* 8358 (K.).

PERAK: Ulu Temengoh, *Ridley* 14468 (BM.K.); Temengoh, *Ridley* 14469 (BM.K.); Taiping Hills, *Ridley* 14460 (BM.K.); Chanderiang, Larut, *King's Collector* 519 (K.); Bidor, near Tapah, *Ridley* 14016 (K.).

(*d*) A small creeping form, perhaps a juvenile state.

MALACCA: Mt. Ophir, (Tunduk), *Ridley* 9990 (BM.K).

The species is stated by A. Braun (Ind. Sem. Berol. 1860, p. 22) to have been introduced into cultivation from Borneo by T. Lobb; this is probably an error, as no wild specimens from Borneo are recorded.

There is a specimen in Hb. Kew labelled "Madras, Dr. Shuter". It is probably wrongly localised.

The plant found in China and Japan is now usually considered a distinct species, *S. Doederleinii* Hieron.

21. **S. minutifolia** Spring in Mem. Ac. Belg. XXIV, p. 239, no. 176 (1850).

S. Wattii "Bak.": Ridl. l.c. p. 157, no. 26.

S. phanotricha "Bak." l.c. p. 157, no. 27.

"Mountains on clay banks"—Ridley.

JOHORE: Gunong Blumut, 3,000 ft., *Holttum* 10692 (BM.K.).

SELANGOR: Bukit Hitam, *Ridley* 7818 (K.); Sempang Mines, Ridley 15633 (BM. K.).

PAHANG: Gunong Kajang, P. Tioman, 3,000 ft., creeping on rock face, *Henderson* 18279 (K.).

PERAK: Ulu Batang Padang, *Ridley* 13988 (BM.K.S.); Temengoh, *Ridley* 14472 (BM.K.); Gunong Inas, *Wray* 4142 (S.).

KELANTAN: Gunong Sitong, *Nur* 12199 (BM.K.).

Geographical Range: Burma (Mergui).

This species is allied to the Philippine *S. nummularia* Warb. but has more acute lateral leaves.

S. Wattii Bak. has ciliate lateral leaves and long aristate median leaves.

The identification with *S. minutifolia* is rather doubtful as the Mergui plant is still very imperfectly known.

22. S. alutacia Spring in Bull. Ac. Brux. X, p. 233, no. 154 (1843).

S. alutacea Spring in Gaudich. Voy. Bonite Bot. 1, p. 353 (1844–6) errore; Bak. in Journ. Bot. XXIII, p. 175 (1885).

S. pinangensis Spring l.c. p. 227, no. 107; Ridl. l.c. p. 149, no. 6 (1919).

Lycopodioides pinangense (Spring) O. Ktze. Rev. Gen. p. 827 (1891).

S. Kunstleri Bak. in Kew Bull. 1893, p. 14, no. 39.

S. Wrayi Bak. Fern Allies p. 113, no. 296 (1887).

S. oligostachya Bak. in Ann. Bot. VIII, p. 132, no. 272 (1894).

S. Tansleyi Bak. in Kew Bull. 1906, p. 205, no. 420.

S. montana Ridl. in Journ. R. As. Soc., Str. Br., no. 80, p. 159, no. 33 (1919).

S. *alutacea* var. *sphaerophylla* Bak. in Journ. Bot. XXIII, p. 175 (1883).

JOHORE: Gunong Pulai, *Ridley* 12137 (K.), *Holttum* 18076 (BM.).

MALACCA: *Cantley* (BM.); Gunong Mering, *Ridley* 3347 (type of *S. oligostachya* Bak., K.).

NEGRI SEMBILAN: Gunong Angsi, *Ridley* 11873 (K.); 2,500 ft., *Nur* 11562 (K.); Bukit Tangga, *Ridley* (K.).

SELANGOR: Damansara Hill, Kuala Lumpur, *Ridley* (K.); Bukit Kutu, 3,000 ft., *Ridley* 7829 (K.), 7824 (BM.K.); Ulu Gombak, *Ridley* (K.); rocks at the Tunnel, Klang Gates, *Ridley* (K.); Rawang, *Ridley* 7821 (K.); rocks at Gua Batu, *Ridley* 8150 (S.); Ginting Simpah, *Hume* 8843, 8597, 8497, 9743, 9745, 9531, 8834, 9014, 9380 (all S.); Semenyih, *Hume* 7906 (S.).

PAHANG: Gunong Tahan, 3,300 ft., *Wray & Robinson* 5363 (BM.K.), 5375 (BM.), *Ridley* 15954 (K.), 15959 (K.); Wray's camp, Gunong Tahan, *Ridley* 16200 (type of *S. montana* Ridley, K.); Kuala Lipis, *Machado* 11558 (K.); Sungei Reriang, G. Tahan on rocks by stream, *Holttum* 20574 (BM.).

PERAK: "Perak or Selangor", *Tansley* (type of *S. Tansleyi* Bak., K.); Taiping Hills, *Ridley* 11425 (BM.K.); Waterfall, Taiping, *Ridley* 14462 (BM. K.); Sungei Siput, *Ridley* 11898 (BM.K.); Ulu Temengoh, *Ridley* 14471 (BM.K.); Larut, 100–300 ft., *King's Collector* 1866 (type of *S. Kunstleri* Bak., K.); Taiping, *Ridley* 14460 (K.); Temengoh, *Ridley* 14465 (K.), 14464 (BM.K.), 14473 (K.BM.S.); Tapah, *Ridley* 14024 (BM.K.); Bukit

Kamuning, Sungei Siput, *Ridley* 11871 (K.), 11870 (K.); Gunong Keledang, *Ridley* 9576 (K.); Bujong Malacca, *Ridley* (BM.), 4,000 ft., *Curtis* 3308 (S.). Birch's Hill, *Wray* 668 (type of *S. Wrayi* Bak., (K.).

DINDINGS: Lumut, *Ridley* 10349 (K.), 7215 (K.BM.), *Curtis* (S.).

TRENGGANU: Bundi, *Rostados* (K.).

KEDAH: Kedah Peak, 3,000 ft., *Robinson & Kloss* 6098 (K.), in shade of rocks by path, *Holttum and Haniff* 14900 (K.).

PENANG: *Gaudichaud* 7 (Paris, type of *S. pinangensis* Spring); *Lobb* (BM.); Penang Hill, *Ridley* (K.); on banks. *Pinwill* (K.).

S. **alutacia** var. **scabrida** (Ridley) Alston, comb. nov.

S. scabrida Ridley in Journ. R. As. Soc., Str. Br., no. 80, p. 159, no. 32 (1919). Leaves hairy on both surfaces; stems hairy.

PAHANG: Gunong Tahan, *Ridley* 15960 (K.).

The type specimen is very distinct looking, but *Nur* 11562 (BM.) is intermediate between this and the common form.

S. **alutacia** var. **pensile** (Ridley) Alston comb. nov.

S. pensile Ridley in Journ. R. As. Soc., Str. Br., no. 80, p. 150, no. 8 (1919). An extreme form with larger, more acute leaves.

PERAK: Gunong Inas, 5,500 ft., pendent on damp shady rocks, *Yapp* (K.).

Ridley 15954 & 16200 connect it with the ordinary form.

S. **alutacia** var. **Curtisii** (Ridl.) Alston comb. nov.

S. Curtisii Ridley in Journ. R. As. Soc., Str. Br., no. 80, p. 148, no. 2 (1919) Lateral leaves overlapping.

PERAK: Bujong Malacca, *Curtis* 3378 (K.S.).

S. alutacia is "dull olive green" according to Wray & Robinson (no. 5363).

The Assam plant referred to *S. pinangensis* by Spring is quite a different species near *S. praetermissa* Alston.

The Kew specimen looks distinct, but that in Hb. Singapore shows a complete transition to the common form of the species.

23. **S. ciliaris** (Retz.) Spring in Bull. Ac. Brux. X, p. 231, no. 136 (1843).

Lycopodium ciliare Retz. Obs. V, p. 32, no. 92 (1789).

SINGAPORE: Gallang, *Ridley* 10828 (K.).

MALACCA: *Griffith* (K.).

NEGRI SEMBILAN: Sungei Ujong, *Alvins* 2166 (S.).

SELANGOR: Batu Caves, *Ridley* (K.).

KELANTAN: Kuala Aring, *Yapp* 111 (K.).

Geographical Range: India to Australia.

24. **S. Morgani** Zeiller in Bull. Soc. Bot. Fr. XXXII, p. 78 (1885).

PAHANG: Cameron's Highlands, 5,000 ft., *Holttum* 23385, (BM.); top of Falls 4,800 ft. *Henderson* 17770 (BM.); Gunong Berumban, *Ridley* 13985 (K.), 13986 (K.).

PERAK: Gunong Riam, 1950m., *J. de Morgan* (K.); Gunong Kerbau, *Robinson* (K.).

Geographical Range: Endemic.

Perhaps only a form of *S. alutacia* Spring, but the sub-erect habit and ovate, less strongly ciliate lateral leaves, appear distinctive.

25. **S. ornata** (Hk. & Gr.) Spring in Bull. Ac. Brux. X, p. 232, no. 145 (1843).

Lycopodium ornatum Hk. & Gr. in Hk. Bot. Misc. III, p. 108 (1833).

S. brachystachya var. *ornata* (Hk. & Gr.) Bak. in Journ. Bot. XXIII, p. 180 (1885).

S. polita Ridl. in Journ. Fed. Mal. St. Mus. VI, p. 202, no. 348 (1915).

S. Blumei Spring in Bull. Ac. Brux. X, p. 143 (1843).

S. fimbriata Spring in Mem. Ac. Belg. XXIV, p. 258, no. 198 (1850).

S. subfimbriata v.A.v.R. in Bull. Jard. Bot. Buit., ser. 2, I, p. 26 (1911).

S. sclerophila v.A.v.R. in Bull, Jard. Bot. Buit., ser. 3, II, p. 182 (1920).

S. varians v.A.v.R. in Bull. Jard. Bot. Buit., ser. 3, V, p. 237 (1922).

SELANGOR: Semangkok Pass, *Ridley* 12638 (K.), 12038 (K.), 12039 (K.); Sempang, *Ridley* 15631 (BM.K.).

PAHANG: Telom, *Ridley* 13990 (K.); Kuala Teku, *Seimund* 860 (S.), Fraser Hill, 4,000–4,370 ft., *Burkill & Holttum* 8822 (K.), *Nur* 11020 (BM.), *Henderson* 11286 (S.); Gunong Tahan, 5,500–7,000 ft., *Haniff & Nur* 7974 (K.); Teku Woods, G. Tahan, *Ridley* 15958 (BM.K.), 15951 (BM.K.); Wray's Camp G. Tahan, *Ridley* 16195 (K.).

PERAK: Bujong Malacca, *Curtis* 3379 (K.); Larut, 4–5,000 ft., *King's Collector* 2411 (K.), 2361 (K.), 2362 (K.); Gunong Hijau. *Haniff & Nur* 2459 (K.), *Fox* (S.); Taiping, *Hervey* 1678 (BM.); Maxwell's Hill, Taiping, *Ridley* 5181 (S.); Birch's Hill, *Wray* (S.).

Geographical Range: Indo-China, Sumatra, Java, Borneo and Philippines.

The plant (Ridley 7034) referred by Ridley (l.c. p. 160) to *S. suberosa* Spring probably comes here.

SPECIES EXCLUDENDÆ.

S. chrysocaulos (Hk. & Gr.) Spring in Bull. Ac. Brux. X, p. 232, no. 141 (1843).

S. hypnoides Spring in Bull. Ac. Brux. X, p. 141, no. 44 (1843).

Lycopodium chrysocaulon Hk. & Gr. in Hk. Bot. Misc. II, p. 401, no. 182 (1831).

L. argenteum Wall. List, p. 6, no. 127 (1829) pp.

TYPE: Mountains of Penang, *Wallich* 127 (E.K.).

This species was wrongly reported from Penang, the specimens were doubtless from North India.

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Names of species especially dealt with are shown in **heavy type**, synonyms in *italics*.

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Selaginella uncinata arborea, Mett.	45
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Selaginella Wallichii elegans, (Wall.) Warb.	48
Selaginella Wallichii polystachya, Warb.	46
Selaginella Wallichii Walkeri, v.A.v.R.	48
Selaginella Wattii, "Bak".	54
Selaginella Willdenovii (Desv.) Bak.	45
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NOTES ON THE BIOLOGY OF MACARANGA SPP.

By J. A. Baker, B. Sc.

Of the 225 species of Macaranga, 20 only are recorded in the Malay Peninsula. They constitute an outstanding, and often dominant, genus of secondary growth plants, sometimes occurring nearly as a pure stand, but more usually in association with other genera. Their appearance in the succession follows on the preliminary phase of Lallang *(Imperata arundinacea)* and Sendudok *(Melastoma polyanthum)*, and they may be regarded oecologically as the palæotropical counterparts of the neotropical *Cecropiae*, both genera being characteristic of advanced secondary growth and both being "myrmecophilous". It appears that the Macarangas are distributed largely through the agency of birds (e.g. the Punai or Green Pigeon *(Osmotreron vernans)*, which is a regular inhabitant of secondary growth and is also to a large extent responsible for the dissemination of *Melastoma polyanthum* (1, 2.).

STRUCTURES RELATED TO THE PRESENCE OF ANTS.

There are two features with which one may relate the intimate association of ants with many specimens of Macaranga.

These are:—

(1) *Fistular stems.*

(2) *The presence of Food-Bodies on certain parts of the plant.*

(1) *Fistular Stems.*

The young shoots of all species of Macaranga are solid but, as growth advances, the pith, in a number of species, dries out and degenerates, while the surrounding wood increases in thickness and hardness. Hollow internodes are consequently formed into which the ants make their way by biting small holes. The terminal internode is never thus inhabited, nor are the very old internodes, which are presumably abandoned when they become indurated to accommodate the sap-sucking coccids which are kept by the ants inside their nest.

(2) *Food-Bodies.*

These are white multicellular spheres, about 1 m.m. in diameter, which form one of the chief sources of food to the ants, being bitten off by them and carried into the nest (Plate XII, fig. 3). Treatment with iodine shows that

starch is not present; microscopical examination reveals globules of fat or oil which are extruded when the food-body is ruptured by pressure. These globules are soluble in chloroform.

The distribution of the food-bodies varies among different species. In *M. triloba* they are borne on the under surface of the stipules. These stipules are convex and strongly deflexed so as to form a hollow chamber (Plate XII, fig. 1, 2) in which the ants are completely protected while in search of their food.

In *M. hypoleuca* they are borne on the under surface of the leaves, the stipules in this species being lanceolate and narrow. (Plate XI, figs. 1, 2).

Both of these cases are described by RIDLEY (3). I find, however, that there is a third type, represented by *M. Hosei* and *M. Maingayi*, in which the food-bodies are borne only on the upper surface of the very young stipules which, in their early stages, are turned upwards and are protected by the young leaves; these latter form a canopy almost completely surrounding the tip of the shoot (Plate XV, figs. 2, 3). [The discovery of *Macaranga Maingayi*, H.f. in abundance near Gersek and Sungei Kling, Johore is interesting. This species was originally described from specimens collected in Malacca by Maingay and in Perak by Kunstler, and has not been found again in these localities. There is, however, one specimen in Herb. Singapore (C. F. No. 18183 from Selangor) which is doubtfully referable to this species. Superficially it resembles *M. Hosei*, King, but can be distinguished readily by the peltate, not basal, insertion of the petiole. Another point of difference, noted by Mr. Baker, is that in *M. Maingayi* the stipules are irregularly cup-shaped with the concave surface upwards, while in *M. Hosei* they are flat and nearly horizontal, except when very young.—*M. R. Henderson.*]

M. Griffithiana and *M. Kingii* follow the type of *M. triloba.*

RIDLEY (3) is of the opinion that the food-bodies are developed from small plate-like glands (Bladder Glands), which cover the under surface of the leaves and the stipules of all the myrmecophilous species (and some non-myrmecophilous ones), but on this point I have not been able to satisfy myself.

It is to be observed that in all the cases recorded the food-bodies are placed in well-protected positions; they do not appear to be formed on the upper surface of the leaves, on the stems, or on the unprotected surfaces of stipules; their location, moreover, seems to be perfectly definite for

a given species. I have never yet discovered ant food-bodies on the leaves of *M. triloba*, nor any on the lower stipules surface of *M. Hosei*, nor any on the upper surface of *M. Griffithiana* and *M. triloba*. These facts might tempt one to believe that their development was in some way associated with the activities of the ants, were it not that they are indisputably formed on uninhabited, as well as on inhabited, individuals of the species which possess them.

The non-myrmecophilous members of the genus e.g. *M. megaphylla*, *M. tanaria*, *M. recurvata* etc., have no food-bodies, nor are their stems fistular. In *M. recurvata*, *M. triloba*, *M. hypoleuca*, *M. Hosei*, *M. Griffithiana* and *M. Kingii* the leaf veins terminate in cylindrical or club-shaped nectaries (Plate XIII, fig. 4) which are best developed in *M. hypoleuca* (Plate XI, fig. 5). These are functional in the young state and secrete drops of a clean sticky fluid which, curiously enough, is never touched by the ants, though nectaries on most plants are eagerly visited by the ants for the sake of their sugary secretion and, in other ant-plants where they occur (e.g. *Acacia cornigera*) they form an important source of nourishment. On one occasion, moreover, I have seen ants, of an unidentified species, drinking from the marginal nectaries of *Macaranga recurvata* (which is not a myrmecophilous form).

THE ANTS.

The ants regularly associated with *Macaranga spp.* are *Cremastogaster (Decacrema) borneensis* Andre. subsp. *Macarangae* Viehmeyer. This statement is based on specimens from *M. Griffithiana*, *M. hypoleuca* and *M. triloba* respectively, which were kindly determined for me by Mr. Donnisthorpe. The species proved to be identical in each case and, at the same time, corresponded exactly with specimens at the British Museum previously collected by RIDLEY in Singapore.

Having examined a large amount of material I have never found a Macaranga inhabited by any other ant. From time to time the sexual castes may be found and usually many plants in the same vicinity are found to contain these.

I have collected de-alated females both in *M. triloba* and in *M. Hosei*. In one specimen there were 3 adjacent, but unconnected, internodes, each of which contained a queen and some pupæ. In one internode some workers had hatched out, these being sensibly smaller than usual (perhaps on account of inadequate nutrition). Evidently the population of a single plant does not always derive from one queen. Nearby some specimens of *M. Hosei* also proved to contain

queens. In so far as I had examined scores of specimens from the same spot earlier in the year without finding a single female I conclude that, when the ants swarm, they settle down in some locality and enter any suitable species of *Macaranga* which is at hand. The male is a good deal smaller than the female and may be at once distinguished by its longer and finer antennæ. Whenever I have found winged males they have been lodged in the lower internodes of the inhabited shoot, the upper ones containing only workers.

Different species of Macaranga vary a good deal in the extent to which they are inhabited by ants. *M. triloba* is nearly always inhabited and *M. hypoleuca* very generally so. Specimens of *M. Hosei* on the other hand are about as often uninhabited as they are inhabited.

If two plants containing ants are tied together, or otherwise brought into contact, the inquilines engage one another in combat, after the ordinary manner of ants from different nests (their recognition of individuals from their own nest being customarily attributed to a characteristic nest-smell).

RIDLEY (3) recorded the almost universal presence of coccids in the interior of the hollow stems, but as far as I know these have not yet been determined. They are, however, of the degenerate type with greatly reduced legs, and no antennæ. He also regarded them as the only insects ordinarily associated with the ants inhabiting *Macaranga*. I note, however, that on the under surface of the leaves small jassid hoppers are frequently present, at least one species of which bears a strong superficial resemblance to *Cremastogaster*. These jassids are in no way molested by the ants and, in so far as many of the group are known to be "myrmecophilous" (as well as "ant-mimics) it may be that, like the coccids, they are solicited for their secretion.

The detritus within the stem is often teeming with minute nematode worms—a fact recorded by BAILEY (4) in analogous material from *Cordia nodosa*. This observer points to the presence of nematodes in the infrabuccal pellets of some *Pseudomyrminae* and suggests that part of the life-cycle might occur within the ant.

It is also interesting to note that uninhabited stems of *Macaranga* often form a nesting site for a small solitary vespid, determined for me by Mr. PENDLEBURY as a species of *Crabro*. I have found this same wasp in the stems both of *M. hypoleuca* and *M. Griffithiana*. Several of the pupæ proved to be parasitised by a small chalcid.

That the inquilines of myrmecopytes furnish protection to their host plants against the ravages of pests, is a contention that has been hotly disputed from the time when it was first put forward by BELT (5) in connexion with the S. American Cecropias. RIDLEY (3) concluded that the Macarangas were protected in this way against tortricid caterpillars, and all observations that I have made go to confirm this. A plant that is seriously infested with these caterpillars is almost invariably an uninhabited one. It is equally certain, however, that against many other pests the ants constitute no protection at all. Trees are often seen with their leaves severely attacked by leaf-eating insects, in spite of being inhabited by ants. In this case the parasite is presumably a flying one, in so far as there is no trace of it on the plant itself. Spherical galls are also common on the leaves and petioles of *M. triloba* and *M. hypoleuca.*

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EXPLANATION OF PLATES

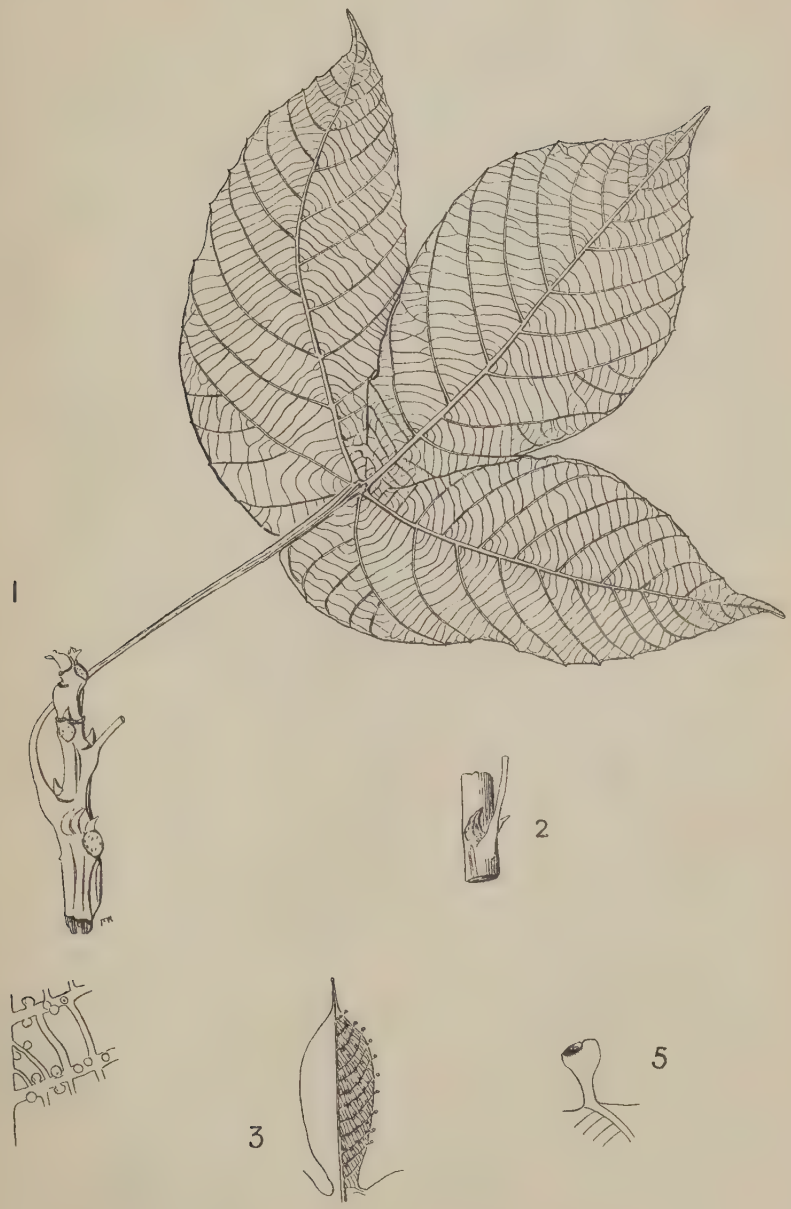
Plate XI. **Macaranga hypoleuca.** 1. Shoot with leaf; 2. Detail of ditto showing shape and position of stipules; 3. Middle lobe of young leaf with food bodies and nectaries (under surface); 4. Detail of ditto showing insertion of the food bodies. The waxy excretion which covers the under surface of the leaf is not shown in this diagram; 5. A marginal nectary.

Plate XII. **Macaranga triloba.** 1. Shoot with leaf; 2. Detail of ditto showing deflexed stipules; 3. Usual section of stipule showing food body.

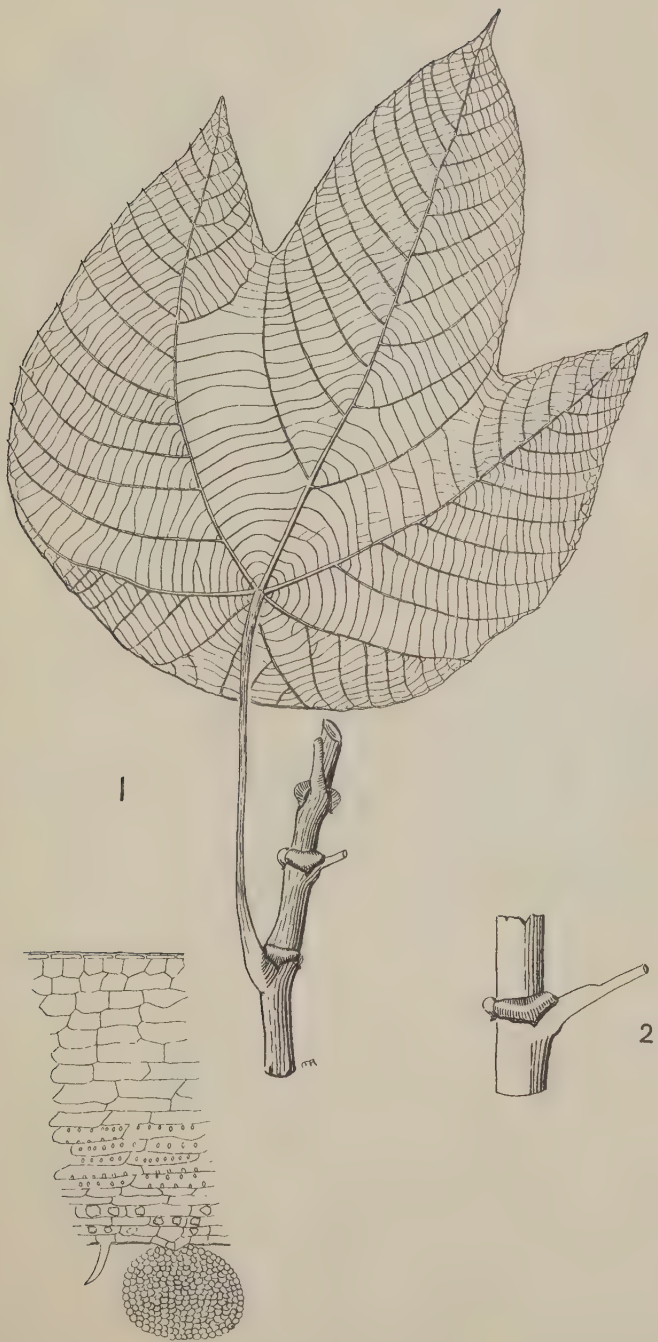
Plate XIII. **Macaranga Maingayi.** 1. Shoot with leaves; 2. Detail of ditto showing stipules; 3. Middle lobe of young leaf (under surface); 4. Marginal nectary.

Plate XIV. **Macaranga Hosei.** 1. Shoot with leaf; 2. Middle lobe of young leaf (under surface); 3. T.S. Stem showing stipules from above; 4, Under surface of young leaf, showing "bladder-glands" much enlarged; 5. Young stipules seen from above showing food-bodies on upper surface; 6. Tip of growing shoot showing the manner in which the food-bodies are protected by the young leaves.

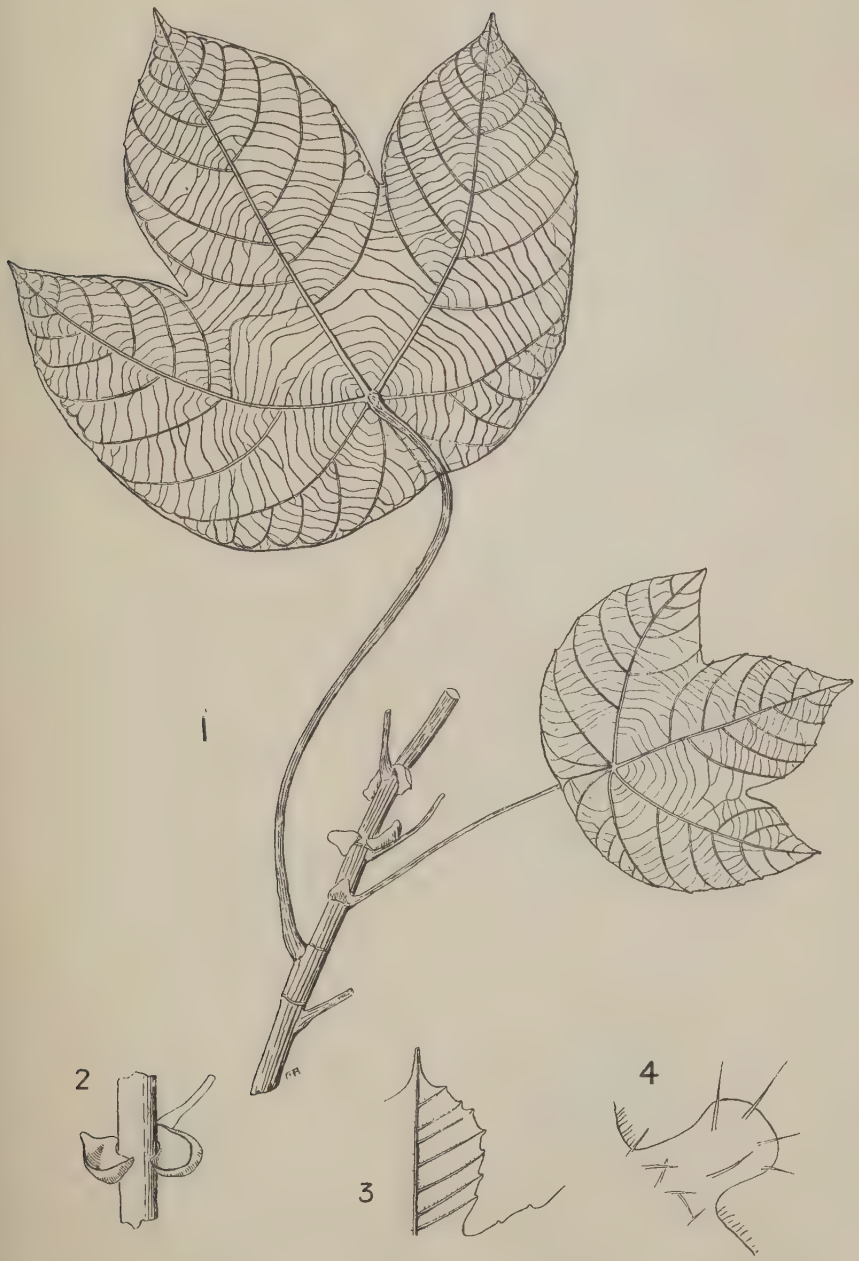
Plate XV. **Macaranga Griffithiana.** 1. Shoot with leaf; 2. Under surface of stipule showing food-bodies; 3. Under surface of leaf showing "bladder-glands" and wax-bodies.



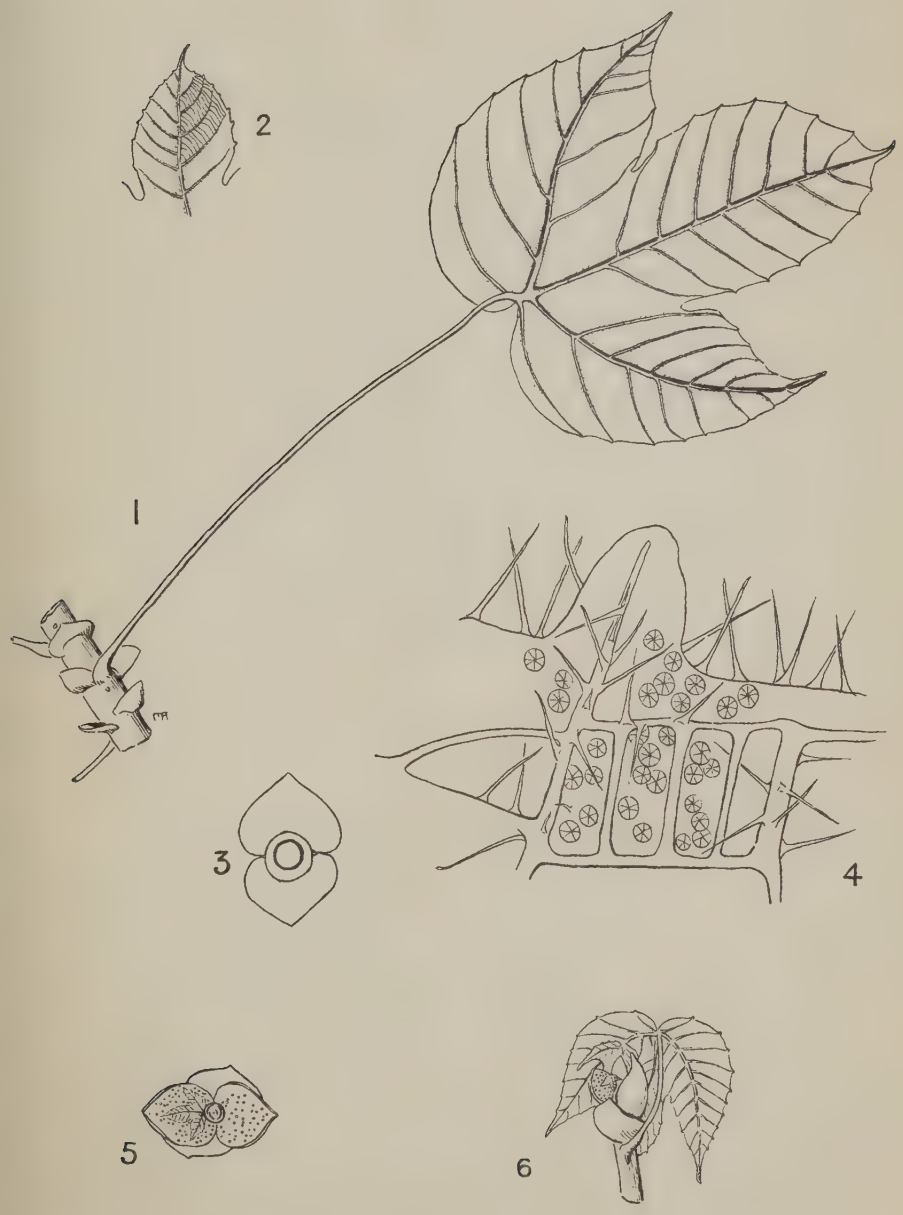
Macaranga hypoleuca



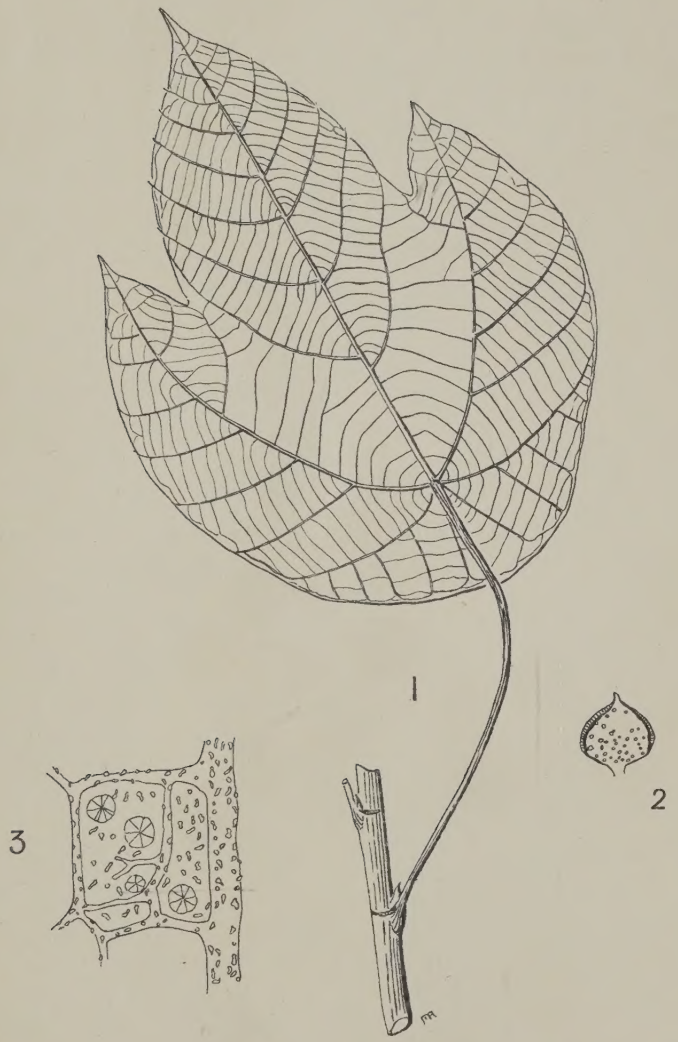
Macaranga triloba



Macaranga Maingayi



Macaranga Hosei



Macaranga Griffithiana

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